

Resource Conservation and Recovery Act Post-Closure Care Permit Application

For U.S.D.O.E -Rocky Flats Plant
Hazardous & Radioactive Mixed Wastes

CO7890010526

5 October 1988

Volume XVI

[REDACTED]

REVIEWED FOR CLASSIFICATION/UCM

By [Signature]
Date 4/6/92

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For U S D O E -Rocky Flats Plant
Hazardous & Radioactive Mixed Wastes

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Volume XVI

Prepared by:

ROCKWELL INTERNATIONAL

North American Aerospace Operations

In Association with

WESTON
MANAGERS DESIGNERS/CONSULTANTS



Chen & Assoc., Inc

REVIEWED FOR CLASSIFICATION/UCM

By K. L. Walters CHN

Date 4/1/92

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Approval by the Department of Energy prior to release is required

RCRA POST-CLOSURE CARE PERMIT
CONTENTS OF VOLUMES

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ORIGINAL PROCESS WASTE LINES

CLOSURE PLAN

**U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO**

OCTOBER 3, 1988

**ROCKWELL INTERNATIONAL
NORTH AMERICAN AEROSPACE OPERATIONS
ROCKY FLATS PLANT**

APPENDIX A
GEOLOGIC DATA

APPENDIX A

This appendix contains borehole logs and well construction summaries for the borings drilled in the vicinity of the Original Process Waste Lines. The appendix is presented in the following order:

- o 1986 Monitor Wells
- o 1987 Monitor Wells
- o 1987 Boreholes

EXPLANATION OF SYMBOLS AND TERMS
ON BORING LOGS

SAMPLE TYPE



Split Spoon



NC Core

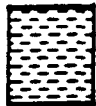


Continuous Drive

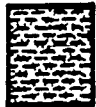


Bulk

GRAPHIC LOG



Clay or Shale



Clayey Sand or Sandy Clay



Gravel



Sand or Sandstone



Sand and Gravel



Silt or Siltstone

WATER CONTENT



WATER LEVEL FOUND DURING DRILLING



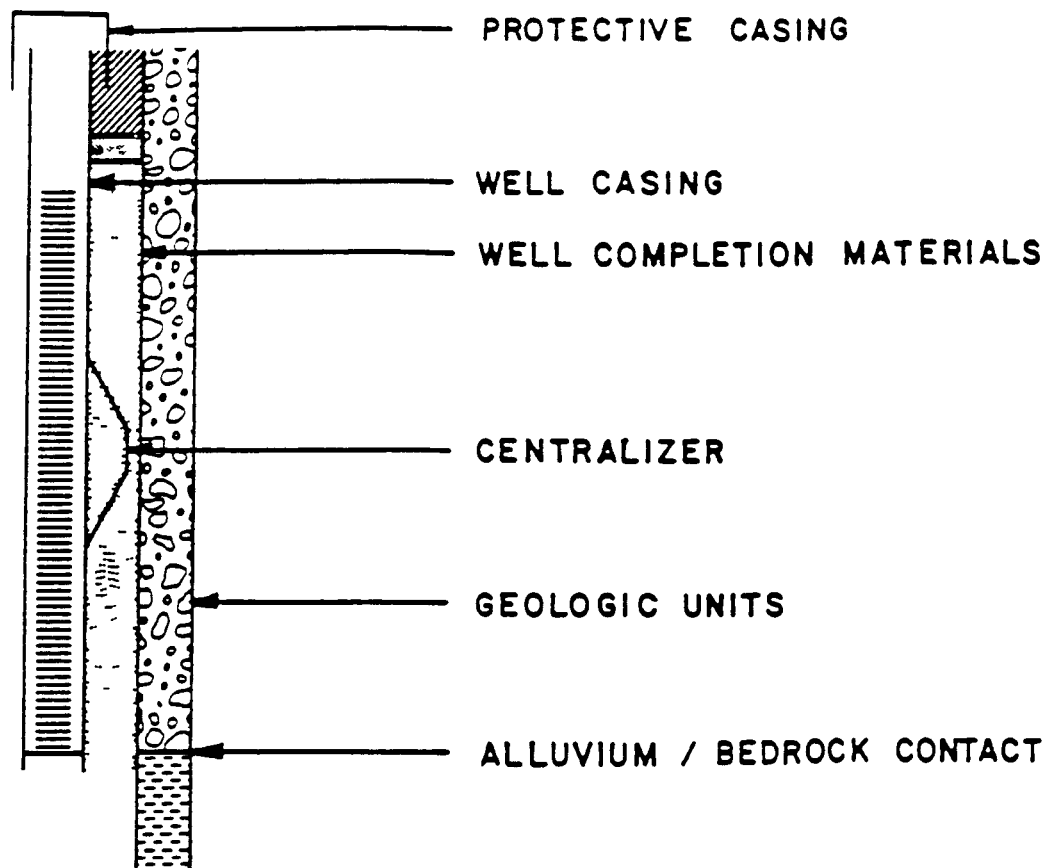
STATIC WATER LEVEL ON 10/13/88

PENETRATION RESISTANCE



STANDARD PENETRATION TEST RESULTS
BLOWS PER INCH.

EXPLANATION OF SYMBOLS ON
WELL CONSTRUCTION SUMMARIES



WELL CASING



BLANK



SCREEN

WELL COMPLETION MATERIALS



CEMENT GROUT



BENTONITE PELLETS



SAND PACK



CUTTINGS

GEOLOGIC MATERIALS

EXPLANATION PRESENTED IN LOG OF BORING
EXPLANATION

1986 MONITOR WELLS

INDEX OF DATA

Boring No 4-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdriograph

Project Rocky Flats Plant

LOG OF BORING NO.

4-86

Date Drilled 4/24/86

Coordinates N 40437.1 E 30774 2

Boring Method Hollow Stem Auger

Ground Surface Elevation 5636.60

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL ALLOUVIUM					
				0-0 7' CLAY dark brown, silty, trace granitic pebbles; moist					
				0 7-1 5' CLAY medium to dark brown, some very fine-grained sand, moist					
				1 5-2 7' SAND medium to dark brown, poorly sorted, fine to coarse, quartz and feldspar, silty clay partings, moist					
	3			2 7-3 0' CLAY dark grayish brown, iron stains and trace granitic pebbles, silty, moist to wet					
				3 0-8.0'-Sample Recovered 1 7/5.0'=34%					
				3.0-4 0' CLAY. Same as above, moist to wet.					
	6			6.3-8 0' CLAY dark grayish brown; silty, iron stains and trace granitic pebbles, moist to wet					
				8 0-10 5'-Sample Recovered 0 7/2 5'=28%					
				8 0-8.7' CLAY dark brown, silty, trace grading to some granitic cobbles, moist					
	9			10 5-13 0'-Sample Recovered 1 3/2.5'=52%					
				11 7-12.2' CLAY medium to dark brown, some granitic pebbles and cobbles; sandy to gravelly, moist					
				Wet at 12.0'.					
	12			12.2-13.0' CLAY medium brown to medium gray, sandy to gravelly, some granitic pebbles and cobbles, iron staining, wet					

Remarks

Logged by S Paschke

Checked by

BSP

Project No.

106P06222

Hydro-Search, Inc.

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Project Rocky Flats Plant		LOG OF BORING NO. 4-86	
Date Drilled 4/21/86		Coordinates N 40437 1 E 30774.2	
Boring Method Hollow Stem Auger		Ground Surface Elevation 5636.60	

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch) 20 40	Water Content (%) 20 40	Other Tests
	12			13.0-15 5'-Sample. Recovered 2 1/2 5'=84% 13 0-14 7' CLAY medium gray, some fine to coarse sand and some granitic pebbles, iron staining, wet 14 7-14 9' CLAY medium gray, some fine to coarse sand and granitic pebbles, iron staining, wet			
	15			ARAPAHOE FORMATION 15 5-18 0'-Sample Recovered 2.5/2 5'=100% CLAYSTONE medium gray, slightly sandy; moist			
	18			TOTAL DEPTH 18.0'			
	21						
	24						

Remarks	Logged by S Paschke	Checked by <i>BP</i>
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ELEVATION GROUND LEVEL 5636 60'
TOP OF CASING 5637 94'

CONSTRUCTION TIME LOG

<u>TASK</u>	<u>START</u>		<u>FINISH</u>	
	<u>DATE</u>	<u>TIME</u>	<u>DATE</u>	<u>TIME</u>
DRILLING	1986		1986	
7½" auger	4/24	1440	4/24	1600
GEOPHYS LOGGING	—	—	—	—
CASING				
2" stainless	4/24	1725	4/24	1730
FILTER PLACEMENT	4/24	1730	4/24	1810
CEMENTING	4/25	1010	4/25	1020
DEVELOPMENT	8/29	1606	8/29	1606
OTHER				
Bentonite	4/25	1000	4/25	1010

WELL DEVELOPMENT

See Well Development Summary Sheet

Water encountered at 12 00' during drilling.

Top of stainless steel casing 1 34'

INDEX OF DATA

Boring No 11-86

Completed as well? yes

Data in File

- λ Log of Borehole
- X Well Construction Summaries
- Well Development Summaries
- Hydraulic Conductivity Test Data
and Results
- Packer Test Data and Results
- Water Level Data
- Saturated Thickness Hvdriograph

Project Rocky Flats Plant		LOG OF BORING NO. 11-86	
Date Drilled 9/5/86		Coordinates N 40321.2 E 26931 0	
Boring Method Hollow Stem Auger		Ground Surface Elevation 5712.19	

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL ALLOVIUM					
				0 0-2 0'-Sample Recovered 2 0/2 0'=100%					
				0 0-0 7' SAND AND GRAVEL Grayish brown (5YR 3/2), some granitic pebbles, roots and grasses common, poorly sorted, angular, unconsolidated, dry.					
	2.5			0 7-2 0'-Sample GRAVEL grayish brown (5YR 3/2) fine- to medium-grained sand and gravel, few roots, poorly sorted, subangular, unconsolidated, dry					
				2 0-3 0'-Sample Recovered 1 0/1 0'=100% GRAVEL dark yellowish brown (10YR 4/2) with very coarse grained granitic pebbles, some red (5R 4/6) iron staining, poorly sorted, angular to subrounded; unconsolidated; dry					
	5			3 0-6 0'-Sample Recovered 0 0/3 0'=0%					
				6.0-8 0'-Sample Recovered 0 8/2 0'=40% SAND grayish red (5R 4/2) coarse to fine-grained with several quartzite and granite pebbles, poorly sorted, angular, unconsolidated, dry					
	7.5			8.0-10 0'-Sample. Recovered 1.5/2 0'=75%					
				8.5-9 5'. SAND AND GRAVEL dark yellowish brown (10YR 4/2) with gray quartzite pebbles, poorly sorted; angular, unconsolidated, dry					
				ARAPAHOE FORMATION					
				9 5-10 0' CLAYSTONE pale yellowish brown (10YR 6/2), slightly sandy; moderate yellowish brown (10YR 5/4) mottles, no pebbles, blocky texture, dry					
	10								

Remarks	Logged by J Bergman	Checked by <i>[Signature]</i>
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Project: Rocky Flats Plant

LOG OF BORING NO. 11-86

Date Drilled 9/5/86

Coordinates N 40321.2 E 26931.0

Boring Method Hollow Stem Auger

Ground Surface Elevation 5712.19

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	10			10.0-11.5'-Sample. Recovered 2 0/1 5'=125% 10.0-10 5' CLAYSTONE. dark yellowish brown (10YR 4/2), dry					
				10 5-11 0' CLAYSTONE light olive gray (5Y 5/2) and dark yellowish brown (10YR 4/2) clay with moderate yellowish brown (10YR 5/4) mottles, consolidated, dry					
	12 5			11 0-11 5' SANDSTONE very light gray (N 8/0) with moderate brown (5YR 4/4) fine-grained to medium-grained sand, well sorted, rounded, consolidated, dry					
				11 5-12.0'-Sample Recovered 1 5/1.5'=100% CLAYSTONE moderate yellowish brown (10YR 5/4), dry.					
	15			12 0-13 0'-Sample Recovered 1.0/1.0'=100% SANDSTONE moderate brown (5YR 4/4) and light olive gray (5Y 5/2) very fine- grained to fine-grained sand, homogeneous, well sorted; rounded, well cemented, dry					
				13 0-14.0'-Sample Recovered 1 0/1 0'=100% SANDSTONE medium light gray (N 6/0) fine-grained sand, few black organic particles, well sorted, silica cement, Last 1 0" contains pale yellowish brown (10YR 6/2) and light brown (5YR 6/4) fine- grained to very fine- grained sand, rounded, no clay; dry					
	17 5			14 0-15 0'-Sample Recovered 1 0/1 0'=100%. SANDSTONE medium gray and medium light gray (N6/5) very fine-grained to fine-grained sand; some patches of pale yellowish brown (10YR 6/2) sand, well sorted, rounded; well cemented, dry					
	20			TOTAL DEPTH 15 0'					

Remarks

Logged by J. Bergman

Checked by *JJP*

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Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS N 40321 2 E 26931.0

ELEVATION GROUND LEVEL 5712 19'
TOP OF CASING 5714 75'

DRILLING SUMMARY

TOTAL DEPTH Well 10 25' Hole 15 00'
BOREHOLE DIAMETER 7 1/4"

DRILLER Boyles Brothers Drilling Co
15865 W 5th Avenue
Golden, CO (Tony Robinson)

RIG Acker
BIT(S) Bull nose bit

DRILLING FLUID None

SURFACE CASING 5" x 4' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

<u>0 0'</u>	<u>3 94'</u>	<u>C1</u>	<u> </u>	<u> </u>	<u> </u>
<u>3 94'</u>	<u>- 10 25'</u>	<u>S1</u>	<u> </u>	<u> </u>	<u> </u>

CASING C1 2" I D Sch 5 type 316 stain-
less steel, threaded and flush
jointed.

SCREEN SI 2" I.D. Sch. 5 type 316 stain-
less steel, threaded and flush
jointed. 0.010" wire wrap screen
0 25' welded bottom cap.

CENTRALIZERS Type 304 stainless steel
6 32' - 7 51'

FILTER MATERIAL 32 42 silica sand
3 00' - 10 50'

CEMENT Portland Type I
0 00' - 2 00'

OTHER 3/8" bentonite pellets
2 00' - 3 00'
10 50' - 13 75'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE 1986	TIME	DATE 1986	TIME
DRILLING				
7½" auger	9/5	1315	9/5	1600
GEOPHYS LOGGING	—	—	—	—
CASING				
2" stainless	9/6	1020	9/6	1025
FILTER PLACEMENT	9/6	1025	9/6	1030
CEMENTING	9/6	1045	9/6	1050
DEVELOPMENT	9/8	1500	9/18	1000
OTHER				
Bentonite	9/6	1030	9/6	1035
	9/6	1015	9/6	1020

WELL DEVELOPMENT

See Well Development Summary Sheets

COMMENTS

No water encountered during drilling

Top of stainless steel casing' 2 56'

Cave from TD to 13 75'

LOCATION Golden, CO
PERSONNEL J Bergman

PROJECT 106P06222
Rocky Flats Plant

INDEX OF DATA

Boring No 12-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdriograph

Project Rocky Flats Plant

LOG OF BORING NO. 12-86

Date Drilled 9/6/86

Coordinates N 39343.3 E 24790.5

Boring Method Hollow Stem Auger

Ground Surface Elevation 5777 88

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL ALLUVIUM					
				0 0'-2 0'-Sample Recovered 1.2/2.0'=60% SAND dark yellowish brown (10YR 4/2) very fine-grained sand and clay, trace gray quartzite pebbles, poorly sorted, angular, unconsolidated, moist					
	2 5			2.0-4 0'-Sample Recovered 2 0/2 0'=100% CLAY dark yellowish brown (10YR 5/4) and moderate yellowish brown (10YR 4/2) with some quartzite and granite pebbles and cobbles, poorly sorted, angular, unconsolidated; damp					
	5			4 0'-6.0'-Sample Recovered 2 0/2 0'=100% SAND moderate yellowish brown (10YR 5/4) fine- grained sand and gray quartzite pebbles, poorly sorted, angular to subrounded, unconsolidated, damp.					
	7 5			6 0'-8.0'-Sample Recovered 0 6/2 0'=30% CLAY moderate yellowish brown (10YR 5/4) clay and sandy clay with several granitic pebbles and cobbles, poorly sorted, angular, unconsolidated, damp					
	10			8.0-10.0'-Sample. Recovered 2.0/2.0'=100% SAND pale yellowish brown (10YR 6/2) very fine-grained sand and clay, some granitic pebbles, poorly sorted, angular, unconsolidated, damp					

Remarks Logged by J Bergman

Checked by 

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106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 12-86

Date Drilled 9/6/86

Coordinates N 39343.3 E 24790 5

Boring Method Hollow Stem Auger

Ground Surface Elevation 5777.88

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	10			10 0-11 0'-Sample Recovered 1 0/1.0'=100% CLAY pale yellowish brown (10YR 6/2) clay with trace granitic pebbles poorly sorted, angular to rounded, unconsolidated, damp					
				ARAPAHOE FORMATION					
	12 5			11.0-12 0'-Sample Recovered 1 0/1 0'=100% CLAYSTONE pale yellowish brown (10YR 6/2) and light brown (5YR 5/6), consolidated, weathered, dry					
				12 0-14 0'-Sample Recovered 2 0/2 0'=100% CLAYSTONE dark yellowish brown (10YR 4/2) with some moderate brown (5YR 4/4) mottles, consolidated, dry					
	15			14 0-16 0'-Sample Recovered 2 0/2.0'=100% CLAYSTONE dark yellowish brown (10YR 4/2) and moderate yellowish brown, consolidated, dry.					
				TOTAL DEPTH 16 0'					
	17 5								
	20								

Remarks Logged by J Bergman

Checked by *[Signature]*

Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS

N 39343 3 E 24790 5

ELEVATION GROUND LEVEL 5777 88'

TOP OF CASING 5780 56'

DRILLING SUMMARY

TOTAL DEPTH Well 11 30' Hole 16.00'

BOREHOLE DIAMETER 7 1/2"

DRILLER Boyles Brothers Drilling Co

15865 W 5th Avenue

Golden, CO (Tony Robinson)

RIG Acker

BIT(S) Bull nose bit

DRILLING FLUID None

SURFACE CASING 5" x 4' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

0 0' - 2 04' C1

2 04' - 11 3' S1

CASING C1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed.

SCREEN S1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrap screen, 0.25' welded bottom cap.

CENTRALIZERS Type 204 stainless steel
6 18' - 7 35'FILTER MATERIAL 32-42 silica sand
2 40' - 11 50'CEMENT Portland Type I
0 00' - 2 00'OTHER 3/8" bentonite pellets
2 00' - 2 40'
11 30' - 11 50'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE 1986	TIME	DATE 1986	TIME
DRILLING 7 1/2" auger	9/6	1315	9/6	1500
GEOPHYS. LOGGING	—	—	—	—
CASING 2" stainless	9/6	1655	9/6	1600
FILTER PLACEMENT	9/6	1700	9/6	1730
CEMENTING	9/6	1735	9/6	1740
DEVELOPMENT	9/8	1345	9/9	1505
OTHER Bentonite	9/6	1730	9/6	1735
	9/6	1650	9/5	1655

WELL DEVELOPMENT

See Well Development Summary Sheets

COMMENTS

Water encountered at 9.0' during drilling

Top of stainless steel casing 2.68'

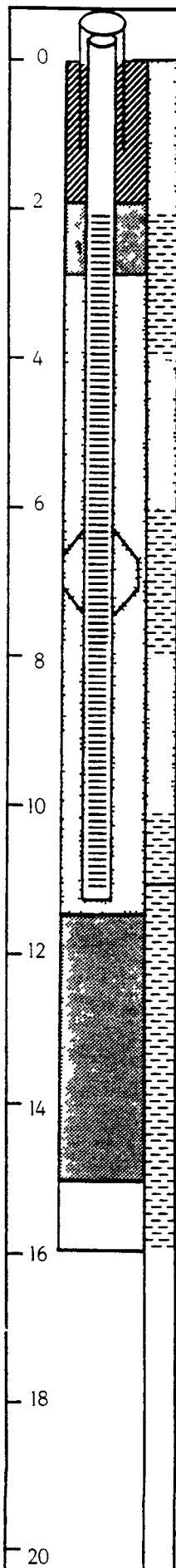
Cave from TD to 15 10'

LOCATION Golden, CO

PERSONNEL J. Bergman

PROJECT 106P06222

Rocky Flats Plant



INDEX OF DATA

Boring No 13-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdiograph

Project Rockv Flats Plant

LOG OF BORING NO. 13-86

Date Drilled 8/20/86

Coordinates N 38867 0 E 22951.0

Boring Method Hollow Stem Auger

Ground Surface Elevation 5837.22

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL ALLUVIUM					
				0.0-2.5'-Sample Recovered 0 0/2 5'=0% COBBLES micaceous granite cobbles and pebbles, poorly sorted, unconsolidated, dry					
				2.5-5.0'-Sample Recovered 0 0/2.5'=0% CLAY dark yellowish brown (10YR 4/2), trace of sand and gravel, poorly sorted, unconsolidated, damp					
	5			5.0-8.0'-Sample Recovered 2.0/3 0'=67% CLAY dark yellowish brown (10YR 4/2) and dusky brown (5YR 2/2) silty, sandy clay, gray quartzite cobbles from 6.7-7.0', rounded, damp					
				8.0-9.0'-Sample Recovered 0 5/1 0'=50% GRAVEL moderate yellowish brown (10YR 5/4) and medium light gray (N6) sandy gravel, some silty clay; poorly sorted, unconsolidated; damp					
	10			ARAPAHOE FORMATION					
				9.0-13.0'-Sample Recovered 3 5/4 0'=75% 9.0-10.1' CLAYSTONE light olive gray (5Y 6/1), consolidated, dry					
				10.1-10.7' CLAYSTONE grayish orange (10YR 7/4) sandy claystone, consolidated, dry.					
	15			10.7-13.0' CLAYSTONE light gray (N 7) silty claystone, consolidated, dry					
				13.0-15.5'-Sample Recovered 2 5/2.5'=100% CLAYSTONE moderate yellowish brown (10YR 5/4) silty claystone with traces of limonite concre- tions, blocky texture, consolidated; dry					
	20			TOTAL DEPTH 15.5'					

Remarks

Logged by L. Pivonka

Checked by

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106P06222

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GROUND LEVEL _____
TOP OF CASING _____ 5839 94'

CONSTRUCTION TIME LOG

WELL DESIGN

10 50' - 14 50'

<u>TASK</u>	<u>START</u>		<u>FINISH</u>	
	<u>DATE</u>	<u>TIME</u>	<u>DATE</u>	<u>TIME</u>
DRILLING	1986		1986	
<u>7½" auger</u>	<u>8/20</u>	<u>1230</u>	<u>8/20</u>	<u>1340</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
GEOPHYS LOGGING	—	—	—	—
CASING				
<u>2" stainless</u>	<u>8/20</u>	<u>1607</u>	<u>8/20</u>	<u>1609</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
FILTER PLACEMENT	<u>8/20</u>	<u>1609</u>	<u>8/20</u>	<u>1623</u>
CEMENTING	<u>8/20</u>	<u>1630</u>	<u>8/20</u>	<u>1641</u>
DEVELOPMENT	<u>9/3</u>	<u>1035</u>	<u>9/3</u>	<u>1035</u>
OTHER				
<u>Bentonite</u>	<u>8/20</u>	<u>1623</u>	<u>8/20</u>	<u>1625</u>
_____	<u>8/20</u>	<u>1605</u>	<u>8/20</u>	<u>1607</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

WELL DEVELOPMENT

See Well Development Summary Sheets

COMMENTS

Water encountered at 5.0' during drilling

Top of stainless steel casing 2.72'

Cave from TD to 14 50'

HYDRO-SEARCH RENO•DENVER

CONSULTING HYDROLOGISTS-GEOLOGISTS

LOCATION Golden, COPERSONNEL I Pivonka

06F06222

Rocky Flats Plant

PROJECT

INDEX OF DATA

Boring No 14-86

Completed as well? Yes

Data in File

- X Log of Borehole
- X Well Construction Summaries
- Well Development Summaries
- Hydraulic Conductivity Test Data
and Results
- Packer Test Data and Results
- Water Level Data
- Saturated Thickness Hydrograph

Project		Rocky Flats Plant		LOG OF BORING NO.				14-86
Date Drilled		8/19/86, 8/28/86		Coordinates		N 38866.4 E 22737.6		
Boring Method		Hollow Stem Auger/NC Core		Ground Surface Elevation		5844.71		

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	0			VALLEY FILL ALLUVIUM 0-0 9'-Sample Recovered 0 9/0 9'=100% CLAY dark gray (N 3) clay, some granitic gravel, blocky texture, poorly sorted, unconsolidated, dry			
	2.5			0 9-4 7'-Sample Recovered 3 6/3.8'=95% CLAY dark yellowish brown (10YR 4/2) and dusky yellowish brown (10YR 2/2) sandy, gravelly clay with some rounded gray quartzite cobbles, few iron stains, poorly sorted, unconsolidated, dry			
	5			4 7-8.0'-Sample. Recovered 3 3/3.3'=100% CLAY grayish brown (5YR 3/2) silty clay, granitic gravel and cobbles from 7 7-8 0', trace of iron staining mottled through entire interval, dry			
	7.5						
	10			8.0-10.5'-Sample Recovered 2.5/2.5'=100% CLAY dark yellowish brown (10YR 4/2) silty clay; some granitic pebbles and cobbles; trace iron staining, damp			

Remarks	Logged by L Pivonka & T Gulliver	Checked by <i>[Signature]</i>
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Project No. 106P06222	Hydro-Search, Inc.	Page 1 of 8
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Project		Rocky Flats Plant		LOG OF BORING NO.		14-86	
Date Drilled		8/19/86, 8/28/86		Coordinates		N 38866.4 E 22737 6	
Boring Method		Hollow Stem Auger/NC Core		Ground Surface Elevation		5844.71	

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch) 20 40	Water Content (%) 20 40	Other Tests
	10			10.5-11.0'-Sample. Recovered 0 5/0.5'=100% CLAY Same as above, damp		▽	
				ARAPAHOE FORMATION			
	12 5			11.0-13 0'-Sample. Recovered 2.0/2.0'=100% CLAYSTONE moderate yellowish brown (10YR 5/4) with light gray (N-7) mottling, some iron staining and ironstone concretions, weathered, dry			
	15			13 0-18 0'-Sample Recovered 5.0/5 0'=100% CLAYSTONE Same as above; dry			
	17 5			18.0-23 0'-Sample. Recovered 2 3/5.0'=46% CLAYSTONE Same as above, dry			
	20						

Remarks	Logged by L Pivonka & T Gulliver	Checked by <i>[Signature]</i>
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Project No. 106P06222	Hydro-Search, Inc.	Page 2 of 3
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Project Rocky Flats Plant		LOG OF BORING NO. 14-86			
Date Drilled 8/19/86, 8/28/86		Coordinates N 38866 4 E 22737 6			
Boring Method Hollow Stem Auger/NC Core		Ground Surface Elevation 5844.71			

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	20						
	22.5			23 0-23 3'-Sample. Recovered 0 3/0 3'=100% CLAYSTONE Same as above, dry			
	25			23 3-25 5'-Sample Recovered 2.2/2.2'=100% CLAYSTONE medium dark gray (N 4) claystone, blocky texture, no mottling; unweathered, dry			
	27.5			25.5-28 0'-Sample Recovered 2 0/2.5'=80% CLAYSTONE Same as above, dry			
	30			28.0-30 5'-Sample Recovered 2 1/2 5'=84% CLAYSTONE. Same as above, dry			

Remarks	Logged by L Pivonka & T Gulliver	Checked by <i>[Signature]</i>
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Project No. 106P06222	Hydro-Search, Inc.	Page 3 of 8
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Project.

Rocky Flats Plant

LOG OF BORING NO.

14-86

Date Drilled 8/19/86, 8/28/86

Coordinates N 38866.4 E 22737 6

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5F44 71

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	40			41 6-42 3' CLAYSTONE black (N 1), carbonaceous, damp					
	42.5			42 3-46 5'-Sample Recovered 4 2/4 2'=100% RQD 3 4/4 2'=81%					
				42 3-44 2' SANDSTONE light gray (N 7), very fine-grained, moderately sorted, rounded, massive, damp					
				44.2-44.4' CLAYSTONE greenish gray (5G 6/1), damp					
	45			44 4-46.5' SANDSTONE light gray (N 7), very fine-grained; moderately sorted, rounded, massive, damp					
				46 5-51 5'-Sample Recovered 5 0/5 0'=100% RQD 3 6/5 0'=72%					
	47 5			46 5-50 6' SANDSTONE light gray (N 7), very fine-grained, silty, carbonaceous siltstone laminae, coal coated joints with 40-50 degree dip from 47 5-48 0', moderately sorted, damp					
	50								

Remarks

Logged by L Pivonka & T Gulliver

Checked by 

Project No.

106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO.

14-86

Date Drilled 8/19/86, 8/28/86

Coordinates N 38866 4 E 22737 6

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5844.71

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	50			50 6-51 5' SANDSTONE light gray (N 7), very fine-grained, silty, abundant coal partings, moderately sorted, damp					
				51 5-52.8'-Sample Recovered 1 3/1.3'=100% RQD 1 3/1 3'=100%					
	52 5			51 5-52 2' SANDSTONE light gray (N 7), very fine-grained, silty, some coal partings, moderately sorted, damp					
				52 2-52 4' SANDSTONE light gray (N 7), fine- grained, abundant carbonaceous detritus, moderately sorted, damp					
				52.4-52 8' SANDSTONE light gray (N 7), fine- grained, laminated, moderately sorted; subrounded, damp.					
	55			52.8-56.3'-Sample Recovered 2 9/4.5'=62% RQD 1 8/2.9'=62%					
				52 8-53 3' SILTSTONE dark gray (N 3), clayey, evenly laminated, damp					
				53 3-54 0'. CLAYSTONE grayish black (N 2), 0 10' thick sandstone beds from 53.7-54 0', damp					
	57 5			54 0-55.0'. Lost core					
				55.0-56.3' CLAYSTONE grayish black (N 2), silty; laminated, 15 degree dip, damp					
				56 3-60 9'-Sample Recovered 2.8/4 5'=62%. RQD 1.8/4 5'=40%					
				56.3-57 8' CLAYSTONE dark gray (N 3), silty, laminated; damp.					
	60			57.8-59.5' Lost core					

Remarks

Logged by L. Pivonka & T. Gulliver

Checked by

Project No.

106P06222

Hydro-Search, Inc.

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Project. Rocky Flats Plant			LOG OF BORING NO. 14-86			
Date Drilled 8/19/86, 8/28/86			Coordinates N 38866.4 E 22737.6			
Boring Method Hollow Stem Auger/NC Core			Ground Surface Elevation 5844.71			

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	60			59 5-60.9' SILTSTONE dark gray (N 3), clayey, laminated, 10 degree dip, damp			
				60 9-65 9'-Sample Recovered 5 0/5 0'=100% RQD 1 0/5.0'=20%			
				60 9-63 2' SILTSTONE dark gray (N 3), clayey, laminated, 10 degree dip, damp			
	62 5			63 2-64.5' Lost core			
				64 5-65 9' SILTSTONE grayish black (N 2) to light gray (N 7), clayey, very fine-grained, laminated, damp			
				65 9-70 9'-Sample Recovered 5 0/5 0'=100% RQD 3 6/5 0'=72% SILTSTONE grayish black (N 2) to light gray (N 7), clayey, very fine-grained, laminated, damp.			
	65						
	67 5						
	70						

Remarks	Logged by L Pivonka & T Gulliver	Checked by <i>[Signature]</i>
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Project No. 106P06222	Hydro-Search, Inc.	Page 7 of 8
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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS

N 38866 4' E 22737.6

ELEVATION GROUND LEVEL 5844.71'

TOP OF CASING 5846.73'

DRILLING SUMMARY

TOTAL DEPTH Well 55 36' Hole 74 00'

BOREHOLE DIAMETER 0 00' - 30 50' 7 1/2"

30 50' - 74 00' 4 3/4"

DRILLER Boyles Brothers Drilling Co

15865 W 5th Avenue, Golden, CO

(Jim Horn, Paul Wiebe)

RIG 0 00' - 30 50' Mobile B-57, 30 50' - 74 00' Failing 1500

BIT(S) 0 00' - 30 50' Blade bit, 30 00' -

74 00' Chrisprill 3 3/4", Tricone 4 3/4"

reamer

DRILLING FLUID 0 00' - 30 50' None

30.50' - 74 00' air/water mist

SURFACE CASING 5" x 33 16 steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

0 00' 30.50' C1

0 00' 39 42' C2

39.42' 55 36' S1

CASING C1 5" I D steel surface casing.

C2 2" I D Sch. 5, type 316 stainless steel, threaded and flush jointed.

SCREEN S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0 010" wire wrap screen, 0 25' welded bottom cap

CENTRALIZERS Type 304 stainless steel

46.79' - 48 02'

FILTER MATERIAL 32-42 silica sand 38 15' - 55 36', 16-20 silica sand 55 36' - 56 85'

CEMENT Portland Type I

0 00' - 35 40'

OTHER 3/8" bentonite pellets

35 40' - 38.15'

56 85' - 69 00'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	8/19	1300	8/19	1610
NC core	8/29	0838	8/29	1343
Reaming	9/3	0900	9/3	0917
GEOPHYS LOGGING	—	—	—	—
CASING				
5" steel	8/19	1625	8/20	1008
2" stainless	9/3	1100	9/3	1105
FILTER PLACEMENT	9/3	1105	9/3	1200
CEMENTING	9/3	1200	9/3	1230
LEVELPMENT	9/5	1130	9/17	1100
OTHER				
Bentonite	9/3	1200	9/3	1202
	9/3	0925	9/3	1020
Packer testing	9/2	1100	9/2	1700
Cementing 5" steel	8/20	1008	8/20	1030

WELL DEVELOPMENT

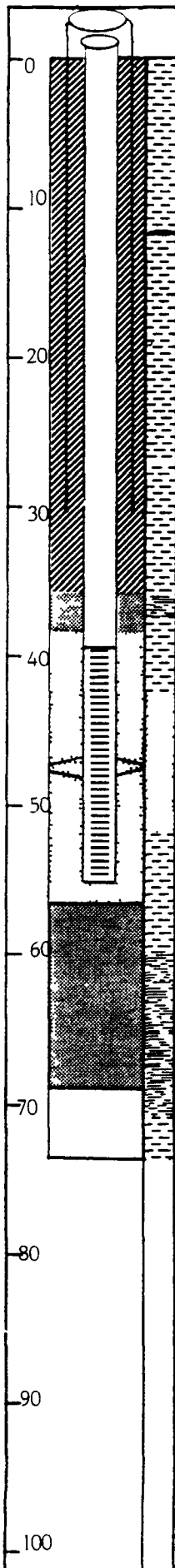
See Well Development Summary Sheet

COMMENTS

No water encountered during drilling

Top of stainless steel casing 2 02'

Cave from TD to 69 00'

LOCATION Golden, CO
PERSONNEL L. Pivonka/T. GulliverPROJECT 106P06222
Rocky Flats Plant

INDEX OF DATA

Boring No 15-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

Project Rocky Flats Plant

LOG OF BORING NO. 15-86

Date Drilled 8/18/86

Coordinates N 38862.9 E 22711.3

Boring Method Hollow Stem Auger

Ground Surface Elevation 5845.61

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL ALLUVIUM					
				0-0 4'-Sample Recovered 0 4/0 4'=100% Medium CLAY dark gray (N 4) top soil, trace granitic pebbles, poorly sorted, unconsolidated, dry			▽		
	5			0 4-5 0'-Sample Recovered 4 0/4 6'=87% GRAVEL dark yellowish brown (10YR 4/2) to dusky yellowish brown (10YR 2/2) granitic and micaceous pebbles and cobbles with some clayey silt, poorly sorted, trace of iron stains, unconsolidated, dry			▽		
	10			5.0-6 0'-Sample. Recovered 1 0/1.0'=100% GRAVEL moderate yellowish brown (5YR 3/4) and pale yellowish brown (10YR 6/2) granitic pebbles and cobbles in a sand and silt matrix, poorly sorted, unconsolidated, dry					
				6.0-8 0'-Sample. Recovered 1.0/2 0'=50% CLAY dark yellowish brown (10YR 4/2) silty clay, trace granitic pebbles, grades to black clay at 7 7', unconsolidated, moist					
	15			8.0-10.5'-Sample Recovered 2 1/2.5'=84% GRAVEL dark yellowish brown (10YR 4/2) granitic pebbles in silty clay matrix; poorly sorted, unconsolidated, wet					
				10 5-13 0'-Sample. Recovered 1.4/2.5'=100%					
				10.5-12.5' GRAVEL. dark yellowish brown (10YR 4/2) granitic pebbles in silty clay matrix; poorly sorted; unconsolidated, wet.					
	20			ARAPAHOE FORMATION					

Remarks

Logged by L Pivonka

Checked by

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 2

Project Rocky Flats Plant

LOG OF BORING NO. 15-86

Date Drilled 8/18/86

Coordinates N 38862 9 E 22711 3

Boring Method Hollow Stem Auger

Ground Surface Elevation 5845.61

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			12.5-13 0'. CLAYSTONE. dark yellowish brown (10YR 4/2), trace iron staining, weathered, moist					
				13 0-15 5'-Sample Recovered 2.5/2 5'=100% CLAYSTONE light olive gray (5Y 6/1) and dusky yellowish brown (10YR 2/2), weathered, dry					
	25			15 5-18 0'-Sample Recovered 2 5/2 5'=100% CLAYSTONE light olive gray (5Y 6/1), trace iron staining, weathered, dry					
				TOTAL DEPTH 18.0'					
	30								
	35								
	40								

Remarks Logged by L Pivonka

Checked by LJP

Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS _____
 N 38862 9 E 22711.3

 ELEVATION GROUND LEVEL 5845 61'
 TOP OF CASING 5847 93'

DRILLING SUMMARY

 TOTAL DEPTH Well 14 69' Hole 18 00'
 BOREHOLE DIAMETER 7 1/2"
 DRILLER Boyles Brothers Drilling Co
 15865 W 5th Avenue
 Golden, CO (Jim Horn)
 RIG Mobile B-57
 BIT(S) Bull nose bit
 DRILLING FLUID None
 SURFACE CASING 5" x 5' steel w/ locking cap

WELL DESIGN

 BASIS GEOLOGIC LOG X GEOPHYSICAL LOG _____
 CASING STRING(S) C=CASING S=SCREEN

0 00'	4 09'	C1	-
4 09'	14 69'	S1	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

 CASING C1 2" I D. Sch 5 type 316 stainless steel, threaded and flush jointed
 SCREEN S1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrap screen 0.25' welded bottom cap
 CENTRALIZERS Type 304 stainless steel 8 34' - 9 52'
 FILTER MATERIAL 12-20 silica sand 3 00' - 18 00'
 CEMENT Portland Type I 0 00' - 2 00'
 OTHER 3/8" bentonite pellets 2 00' - 3 00'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	8/18	1405	8/18	1705
GEOPHYS LOGGING	-	-	-	-
CASING				
2" stainless	8/18	1705	8/18	1707
FILTER PLACEMENT	8/18	1707	8/18	1720
CEMENTING	8/18	1725	8/18	1730
DEVELOPMENT	8/27	1205	9/9	1000
OTHER				
Bentonite	8/18	1720	8/18	1722

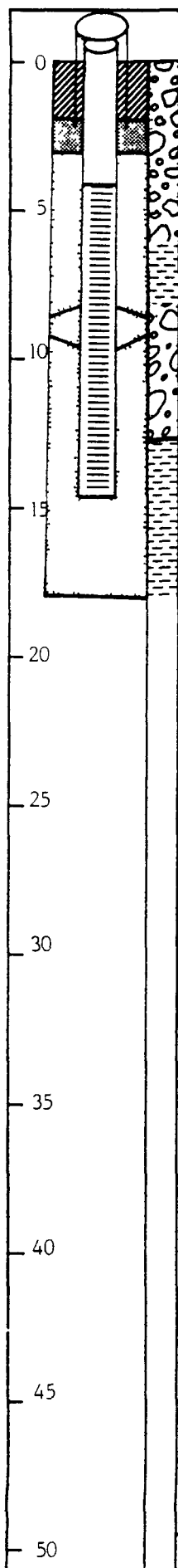
WELL DEVELOPMENT

See Well Development Summary Sheet

COMMENTS

 Water encountered at 6 5' during drilling
 Top of stainless steel casing 2.32'

 LOCATION Golden, Co
 PERSONNEL L Pivonka

 PROJECT 106PU6222
 Rocky Flats Plant


INDEX OF DATA

Boring No 16-86

Completed as well? Yes

Data in File

- X Log of Borehole
- X Well Construction Summaries
- Well Development Summaries
- Hydraulic Conductivity Test Data
and Results
- Packer Test Data and Results
- Water Level Data
- Saturated Thickness Hydiograph

Project		Rocky Flats Plant		LOG OF BORING NO.		16-86	
Date Drilled		8/15/85, 8/25/86		Coordinates		N 38759.9 E 22159 7	
Boring Method		Hollow Stem Auger/NC Core		Ground Surface Elevation		5864.74	

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL ALLUVIUM 0-0 4'-Sample Recovered 0.4/0 4'=100% GRAVEL dark yellowish orange (10YR 6/6) sandy, silty, and clayey, subang- ular grains of feldspar and quartz, poorly sorted, unconsolidated, dry					
	5			0.4-5 0'-Sample Recovered 4 0/4 6'=87% CLAY dusky yellowish brown (10YR 2/2) silty clay, some quartzite pebbles and cobbles, poorly sorted, subangular to subrounded gravel, unconsolidated, dry to damp					
	10			5.0-6 5'-Sample Recovered 1.5/1.5'=100% GRAVEL dark yellowish brown (10YR 4/2) sandy, silty and clayey, granitic pebbles, poorly sorted, unconsolidated, moist					
	15			6.5-7 0'-Sample. Recovered 1 5/1.5'=100% CLAY dark yellowish brown (10YR 4/2), silty, trace iron staining, unconsolidated, damp ARAPAHOE FORMATION 7 0-10 5'-Sample Recovered 3 5/3 5'=100% CLAYSTONE dark yellowish brown (10YR 4/2), silty trace iron staining, laminated, weathered, dry					
	20			10.5-13.0'-Sample. Recovered 2.5/2.5'=100% CLAYSTONE dark yellowish brown (10YR 4/2); silty, trace iron staining; laminated, weathered, dry 13 0-18 0'-Sample Recovered 4 0/5 0'=80% CLAYSTONE dark yellowish brown (10YR 4/2), silty, iron stained, laminated, weathered, dry.					

Remarks	Logged by L Pivonka & T Gulliver	Checked by <i>[Signature]</i>
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Project No. 106P06222	Hydro-Search, Inc.	Page 1 of 4
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Project Rocky Flats Plant				LOG OF BORING NO. 16-86			
Date Drilled 8/15/86, 8/25/86				Coordinates N 38759.9 E 22159 7			
Boring Method Hollow Stem Auger/NC Core				Ground Surface Elevation 5864 74			

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			18 0-23 0'-Sample Recovered 4 3/5 0'=86% CLAYSTONE medium gray (N 5), silty, laminated, unweathered, dry					
				23 0-26 0'-Sample Recovered 3 0/3 0'=100% CLAYSTONE medium gray (N 5), silty, trace iron staining, laminated, dry					
	25			26 0-28 1'-Sample Recovered 2 1/2.1=100% RQD 1 9/2 1'=90% CLAYSTONE medium gray (N 4), carbonaceous laminae, some limonitic partings, damp					
				28 1-32 8'-Sample Recovered 4 7/4 7'=100% RQD 4 7/4 7'=100% CLAYSTONE medium gray (N 4), carbonaceous laminae, some limonitic partings, damp					
	30			32.8-34 0'-Sample Recovered 1 2/1 2'=100% RQD 1 2/1 2'=100% CLAYSTONE Same as above, damp					
				34.0-39 0'-Sample Recovered 3 8/5.0'=76% RQD 3 4/3.8'=90%					
	35			34 0-35 2' Lost core					
				35.2-37 0' CLAYSTONE medium gray (N 4), carbonaceous laminae, some limonitic partings, damp					
				37 0-39.0' CLAYSTONE Same as above, damp					
				39 0-44.0'-Sample Recovered 5 0/5 0'=100% RQD 5 0/5 0'=100%.					
	40			39 0-40 1' CLAYSTONE Same as above, damp					

Remarks	Logged by L Pivonka & T Gulliver	Checked by <i>JLP</i>
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Project No 106P06222	Hydro-Search, Inc.	Page 2 of 4
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Project Rocky Flats Plant				LOG OF BORING NO. 16-86			
Date Drilled 8/15/86, 8/25/86				Coordinates N 38759 9 E 22159 7			
Boring Method Hollow Stem Auger/NC Core				Ground Surface Elevation 5864 74			

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	40			40 1-41 4' SILTSTONE medium gray (N 4), laminated; well sorted, damp			
				41 4-41 9' SILTSTONE dark gray (N 3), laminated, well sorted, damp			
				41 9-43 8' SANDSTONE medium gray (N 5); very fine-grained, massive, some carbonaceous detritus, damp			
	45			43 8-44 0' SILTSTONE dark gray (N 3), clayey, laminated, damp			
				44 0-49 0'-Sample Recovered 5.0/5.0'=100% RQD 4 5/5.0'=90%.			
				44.0-44.8' SILTSTONE dark gray (N 3); clayey, evenly laminated, damp			
	50			44.8-49 0' CLAYSTONE dark gray (N 3), laminated, damp			
				49 0-54 0'-Sample Recovered 5 0/5 0'=100%. RQD 4 4/5 0'=88%			
				49.0-49 6' SILTSTONE dark gray (N 3), slightly calcareous, laminated, damp			
				49.6-51 2' CLAYSTONE grayish black (N 2), silty, damp			
	55			51 2-52.3' SILTSTONE grayish black (N 2); clayey, laminated; damp			
				52.3-54.0' SILTSTONE dark gray (N 3); some very fine-grained sand (light gray (N 7)), convolute bedding, damp to moist.			
				54.0-59.0'-Sample Recovered 1 3/5.0'=26%. RQD 0/1 3'=0%			
	60						

Remarks	Logged by L Pivonka & T Gulliver	Checked by <i>[Signature]</i>
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Project No 106P06222	Hydro-Search, Inc.	Page 3 of 4
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Project Rocky Flats Plant		LOG OF BORING NO. 16-86	
Date Drilled 8/15/86, 8/25/86		Coordinates N 38759.9 E 22159.7	
Boring Method Hollow Stem Auger/NC Core		Ground Surface Elevation 5864.74	

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	60			54 0-54.5' CLAYSTONE medium dark gray (N 4), massive; damp			
				54 5-59.0' SILTSTONE: dark gray (N 3) and very fine-grained light gray (N 7) sandstone, even interlaminated, damp			
				59 0-64.0'-Sample. Recovered 5 0/5 0'=100% RQD 2 5/5.0'=50%.			
	65			59.2-60 7' SILTSTONE medium gray (N 5), clayey; laminated, damp			
				60 7-61.4' CLAYSTONE grayish black (N 2), laminated, damp			
				61.4-64.0' CLAYSTONE medium gray (N 5), silty, laminated, damp			
				TOTAL DEPTH 64.0'			
	70						
	75						
	80						

Remarks	Logged by L Pivonka & T Gulliver	Checked by
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Project No. 106P06222	Hydro-Search, Inc.	Page 4 of 4
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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS

N 38759 9 E 22159 7

ELEVATION GROUND LEVEL 5864.74'

TOP OF CASING 5866.60'

DRILLING SUMMARY

TOTAL DEPTH Well 45.06' Hole 64.00'

BOREHOLE DIAMETER 0.00' - 26.00' 7 1/4"

26.00'-45.00' 4 3/4" 45.00'-64.00' 3 7/8"

DRILLER Boyles Brothers Drilling Co.

15865 W 5th Avenue, Golden, CO

Jim Horne, Paul Wiebe

RIG 0.00'-26.00' Mobile B57, 26.00'-64.00'

BIT(S) 0.00'-26.00' Blade bit failing 1500

26.00'-64.00' Christensen carbide, tricone

4 3/4" reamer

DRILLING FLUID 0.00'-26.00' None

26.00'-64.00' air/water mist

SURFACE CASING 5" x 28.55' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

0.00' 26.00' C1 - -

0.00' - 39.06' C2 - -

39.06' - 45.06' S1 - -

- - - -

- - - -

- - - -

- - - -

- - - -

- - - -

CASING C1 5" I.D. steel surface casing

C2 2" I.D., Sch 5, Type 316 stainless steel, threaded and flush jointed

SCREEN S1 2" I.D., Sch 5, Type 316 stainless steel, threaded and flush jointed, 0.010" wire wrap screen, 0.25' welded bottom cap

CENTRALIZERS Type 304 stainless steel

40.49' - 41.73'

FILTER MATERIAL 32-42 silica sand

37.65' - 45.06'

CEMENT Portland Type I

0.00' - 35.25'

OTHER 3/8" bentonite pellets

35.25' - 37.65'

45.06' - 47.15'

10-20 silica sand 47.15' - 64.00'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/4" auger	8/15	1330	8/15	1530
NC core	8/25	0920	8/25	1200
Reaming	8/27	1700	8/27	1725
GEOPHYS. LOGGING.	—	—	—	—
CASING				
5" steel	8/18	0907	8/18	1110
2" stainless	8/28	1012	8/28	1014
FILTER PLACEMENT	8/28	1018	8/28	1030
CEMENTING	8/28	1130	8/28	1135
DEVELOPMENT	9/2	1725	9/18	1240
OTHER				
Bentonite	8/28	1040	8/28	1041
	8/28	0945	8/28	0948
Packer testing	8/27	0900	8/27	1645
Cementing 5" steel	8/18	0918	8/18	0938

WELL DEVELOPMENT

See Well Development Summary Sheet

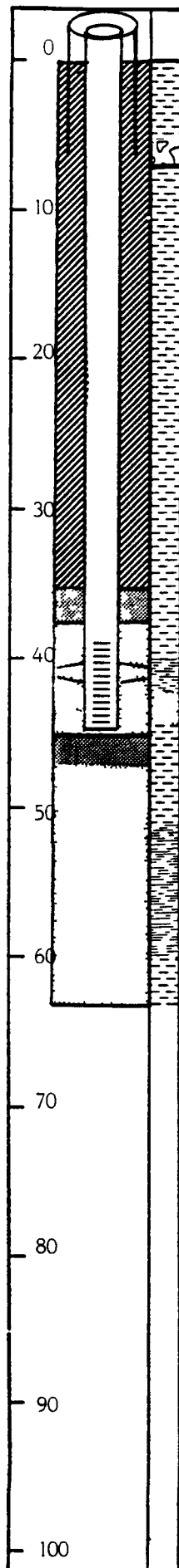
COMMENTS

No water encountered during drilling

Top of stainless steel casing 1.86'

NC core 26.00' - 64.00'

Reamed from 26.00' - 45.00'

LOCATION Golden, CO
PERSONNEL L. Pivonka/T. GulliverPROJECT 106P06222
Rocky Flats Plant

INDEX OF DATA

Boring No 17-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project Rocky Flats Plant

LOG OF BORING NO. 17-86

Date Drilled 8/14/86

Coordinates N 38752.3 E 22141.7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5865.26

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL ALLUVIUM					
				0-0.5'-Sample. Recovered 0 5/0.5'=100% CLAY grayish orange (10YR 7/4), silty and sandy, trace granitic pebbles (subangular), poorly sorted, unconsolidated, dry					
	5			0.5-5 0'-Sample Recovered 3 5/4 5'=88% GRAVEL dusky yellowish brown (10YR 2/2), granitic pebbles and cobbles interbedded with silty clay stringers, approximately 3% iron staining in gravel stringers, poorly sorted; unconsolidated, damp.			▼	▽	
	10			5 0-8 0'-Sample. Recovered 3 0/3 0'=100% GRAVEL dark yellowish brown (10YR 4/2), interbedded granitic pebbles, sand, silt and clay, poorly sorted, subangular, wet.					
				8 0-13 0'-Sample Recovered 2 0/5.0'=40% 8 0-12 5' GRAVEL dark yellowish brown (10YR 4/2) and dark yellowish orange (10YR 6/6) granitic pebbles and cobbles; sandy and silty; poorly sorted, unconsolidated; wet.					
				ARAPAHOE FORMATION					
	15			12.5-13 0'. CLAYSTONE					
				13 0-16 0'-Sample. Recovered 2.8/3 0'=93% CLAYSTONE. Dusky yellowish brown (10YR 2/2) and dark yellowish orange (10YR 6/6), silty; consolidated; weathered, moist					
	20			16 0-19 2'- Sample Recovered 1.8/3.2'=56% CLAYSTONE dark yellowish brown (10YR 4/2), 10% iron staining, consolidated; moist.					
				TOTAL DEPTH: 19.2'					

Remarks

Logged by L Pivonka

Checked by 

Project No.

106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS

N 38752 3 E 22141 7

ELEVATION GROUND LEVEL 5865 26'

TOP OF CASING 5866 55'

DRILLING SUMMARY

TOTAL DEPTH Well 13 98' Hole 19 20'

BOREHOLE DIAMETER 7 1/2"

DRILLER Boyles Brothers Drilling Co.

15865 W 5th Avenue

Golden, CO (Jim Horn)

RIG Mobile B-57

BIT(S) Bull nose bit

DRILLING FLUID None

SURFACE CASING 5" x 5' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG ☒ GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

0 00' 3 73' C1

3.73' 13.98' S1

CASING C1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed

SCREEN S1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed, 0 010" wire wrapped screen, 0 25' welded bottom cap

CENTRALIZERS Type 304 stainless steel
7 97' - 9 09'FILTER MATERIAL 10-20 silica sand
2 50' - 14 00'CEMENT Portland Type I
0 00' - 2 00'OTHER 3/8" bentonite pellets
2 00' - 2 50'
14 00' - 15.25'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	8/14	0931	8/18	1020
GEOPHYS LOGGING	—	—	—	—
CASING				
2" stainless	8/15	1037	8/15	1040
FILTER PLACEMENT	8/15	1040	8/15	1056
CEMENTING	8/15	1100	8/15	1110
LEVELPMENT	9/2	1550	9/22	0920
OTHER				
Bentonite	8/15	1058	8/15	1100
	8/15	1025	8/15	1040

WELL DEVELOPMENT

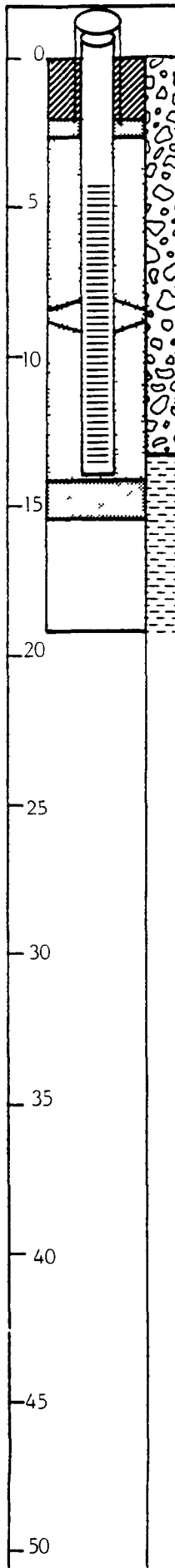
See Well Development Summary Sheet

COMMENTS

Water encountered at 4 8' during drilling

Top of stainless steel casing 1.29'

Cave from TD to 15 25'

LOCATION Golden, CO
PERSONNEL I PivonkaPROJECT 106P06222
Rocky Flats Plant

INDEX OF DATA

Boring No 18-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdiograph

Project

Rocky Flats Plant

LOG OF BORING NO.

18-86

Date Drilled 8/21/86 to 8/22/86

Coordinates N 38532.4 E 22729.8

Boring Method Hollow Stem Auger

Ground Surface Elevation 5882.82

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ARTIFICIAL FILL					
				0-0 6'-Sample Recovered 0 6/0 6'=100% GRAVEL pale yellowish brown (10YR 6/2), granite and quartzite sandy gravel, poorly sorted, unconsolidated, dry					
	5			0 6-5 0'-Sample Recovered 3 4/4 4'=77% CLAY moderate yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/2), salty, trace gray micaceous quartzite cobbles, poorly sorted, hard, damp					
				5 0-8 0'-Sample Recovered 0 0/3 0'=0%					
	10			ARAPAHOE FORMATION					
				8 0-10 5'-Sample Recovered 2 5/2 5'=100% CLAYSTONE medium light gray (N 6) to grayish black (N 2) with dark yellowish orange (10YR 6/6) mottling, sandy, sandy iron stained intervals from 8 0-8 2' and 9 5-10 3', dry					
	15			TOTAL DEPTH 10 5'					
	20								

Remarks

Logged by L Pivonka

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Project No.

106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS _____

ELEVATION GROUND LEVEL 5882 82'

N 38532 4 E 22729.8

TOP OF CASING 5885 49'

DRILLING SUMMARY

TOTAL DEPTH Well 7 50' Hole 10 50'

BOREHOLE DIAMETER 7 1/2"

DRILLER Boyles Brothers Drilling Co

15865 W 5th Avenue

Golden, CO (Jim Horn)

RIG Mobile B-57

BIT(S) Bull nose bit

DRILLING FLUID None

SURFACE CASING 5" x 5' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG _____

CASING STRING(S) C=CASING S=SCREEN

0 00' 3 74' C1

3 74' 7 50' S1

CASING C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.

SCREEN S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed. 0.010" wire wrap screen, 0 25' welded bottom cap

CENTRALIZERS Type 304 stainless steel
4 84' - 6 01'FILTER MATERIAL 32-42 silica sand
3 00' - 8 00'CEMENT Portland Type I
0 00' - 2 00'OTHER 3/8" Bentonite Pellets
2 00' - 3 00'
8 00' - 10 50'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING 7 1/2" auger	1986		1986	
	8/21	0937	8/21	1023
GEOPHYS LOGGING	—	—	—	—
CASING 2" stainless	8/26	0836	8/26	0837
FILTER PLACEMENT	8/26	0837	8/26	0840
CEMENTING	8/26	0842	8/26	0846
DEVELOPMENT	9/3	1015	9/3	1015
OTHER Bentonite	8/26	0840	8/26	0842
	8/26	0834	8/26	0836

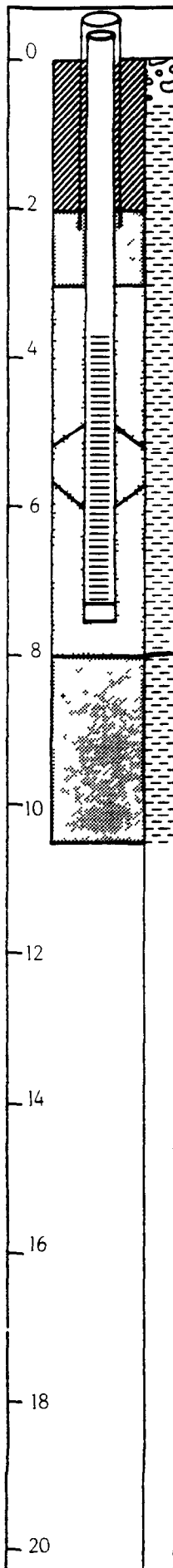
WELL DEVELOPMENT

See Well Development Summary Sheet

COMMENTS

No water encountered during drilling

Top of stainless steel casing 2 67'

LOCATION Golden, CO
PERSONNEL L PivonkaPROJECT 106P06222
Rocky Flats Plant

INDEX OF DATA

Boring No 19-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project Rocky Flats Plant

LOG OF BORING NO. 19-86

Date Drilled 9/11/86

Coordinates N 37941.8 E 20194 7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5931.22

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	0			VALLEY FILL ALLUVIUM			
				0-4 5'-Sample Recovered 3 8/4 5'=84%			
				0-1 7' CLAY dusky brown (5YR 2/2), gravelly, poorly sorted, angular, unconsolidated, dry		▽	
				1 7-4 5' CLAY olive gray (5Y 3/2), some granite and quartzite pebbles, poorly sorted, firm, damp			
	5			4 5-6 5'-Sample Recovered 1 3/2 0'=65% GRAVEL dark yellowish brown (10YR 2/2) to olive gray (5Y 3/2), some sand, silt and clay, poorly sorted, subrounded, unconsolidated, moist to wet		▽	
				6 5-11 5'-Sample Recovered 1.0/5 0'=20% GRAVEL Same as above, grayish black (N 2) from 7 5-8 0', wet.			
	10						
				ARAPAHOE FORMATION			
				11 5-16 5'-Sample Recovered 5 0/5 0'=100% CLAYSTONE pale olive (10Y 6/2) to light olive gray (10Y 5/2), silty, consolidated, wet			
	15						
				TOTAL DEPTH 16 5'			
	20						

Remarks Logged by T. Murphy

Checked by *[Signature]*Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS N 37941 8 E 20194 7

ELEVATION GROUND LEVEL 5931 22'
TOP OF CASING 5932 08'

DRILLING SUMMARY

TOTAL DEPTH Well 12 25' Hole 16 50'
BOREHOLE DIAMETER 7½"

DRILLER Boyles Brothers Drilling Co
15865 W 5th Avenue
Golden, CO (Dave Jarvie)

RIG Mobile B-57
BIT(S) T5

DRILLING FLUID None

SURFACE CASING 5" x 4' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG _____

CASING STRING(S) C= CASING S= SCREEN

[illegible]

CASING C1 2" I D Sch 5 type 316 stain-
less steel threaded and flush
jointed

SCREEN S1: 2" I.D. Sch. 5 type 316 stain-
less steel, threaded and flush
jointed, 0 010" wire wrap screen
0 25' welded bottom cap

CENTRALIZERS Type 304 stainless steel
6.88' - 8.13'

FILTER MATERIAL 32-42 silica sand
2 50' - 12 50'

CEMENT Portland Type I
0 00' - 2 10'

OTHER 3/8" bentonite pellets
2 10' - 2 50'
12.50' - 16 50'

CONSTRUCTION TIME LOG

<u>TASK</u>	<u>START</u>		<u>FINISH</u>	
	<u>DATE</u> 1986	<u>TIME</u>	<u>DATE</u> 1986	<u>TIME</u>
DRILLING				
7 1/2" auger	9/11	0907	9/11	1051
GEOPHYS LOGGING	—	—	—	—
CASING				
2" stainless	9/11	1150	9/11	1155
FILTER PLACEMENT	9/11	1155	9/11	1336
CEMENTING	9/11	1450	9/11	1455
LEVELMENT	9/16	1340	9/17	1435
OTHER				
Bentonite	9/11	1340	9/11	1342
	9/11	1145	9/11	1150

WELL DEVELOPMENT

See Well Development Summary Sheet

COMMENTS

Water encountered at 7 5' during drilling

Top of stainless steel casing 0.86'

LOCATION Golden, CO
PERSONNEL L. Murphy

PROJECT 106P06222
Rocky Flats Plant

INDEX OF DATA

Boring No 20-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project Rocky Flats Plant

LOG OF BORING NO. 20-86

Date Drilled 9/4/86

Coordinates N 38110.3 E 21253.7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5960.47

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ARTIFICIAL FILL					
				0-2 0'-Sample Recovered 1 7/2 0'=85% SAND grayish orange (10YR 7/4) to dark yellowish orange (10YR 6/6) fine- to coarse grained sand, some granitic pebbles and cobbles, fragments of medium gray (N 5) claystone, no apparent bedding, poorly sorted, unconsolidated, dry					
	5			2 0-4 0'-Sample Recovered 2 0/2 0'=100% GRAVEL dark yellowish orange (10YR 6/6) granitic and quartzite pebbles and cobbles, some very fine-grained sand, slightly calcareous, no bedding evident, poorly sorted, unconsolidated, dry					
	10			4 0-6 5'-Sample Recovered 0 3/2 5'=12% GRAVEL dark yellowish orange (10YR 6/6) granitic pebbles and cobbles, some fine-grained sand, poorly sorted, unconsolidated, dry					
				6 5-7 5'-Sample Recovered 0/1.0'=0% BOULDER drilled out large quartzite boulder					
	15			7 5-12 5'-Sample Recovered 0 1/5 0'=2% 7 5-10 0'-Cuttings CEMENT RUBBLE, dry					
				ARAPAHOE FORMATION					
				12 5-17 5'-Sample Recovered 5 0/5 0'=100%					
				12 5-14 8' CLAYSTONE dark yellowish orange (10YR 6/6), silty, damp					
	20								

Remarks

Logged by T Murphy

Checked by 

Project No.

106P06222

Hydro-Search, Inc.

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Project Rocky Flats Plant

LOG OF BORING NO. 20-86

Date Drilled 9/4/86

Coordinates N 38110.3 E 21253.7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5960.47

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			14 8-17 5' CLAYSTONE greenish gray (5GY 6/1) to dark gray (N3), some black (N1) organic fragments, interbedded sand layers consisting of medium to fine-grained sand and silty sand well sorted, damp					
	25			17 5-22 5'-Sample Recovered 4 5/4 5'=100% CLAYSTONE medium brownish gray (5YR 4/4) to olive gray (5Y 4/1), silty, firm, damp					
				TOTAL DEPTH 22 5'					
	30								
	35								
	40								

Remarks Logged by T Murphy

Checked by *[Signature]*

Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS _____
 N 38110 3 E 21253 7

 ELEVATION GROUND LEVEL 5960 47'
 TOP OF CASING 5962 12'

DRILLING SUMMARY

 TOTAL DEPTH Well 10 55' Hole 22 00'
 BOREHOLE DIAMETER 7 1/2"
 DRILLER Boyles Brothers Drilling Co
 15865 W 5th Avenue
 Golden, CO (Dave Jarvie)
 RIG Mobile B-57
 BIT(S) Clay bit
 DRILLING FLUID None
 SURFACE CASING 5" x 4' steel w/ locking cap

WELL DESIGN

 BASIS GEOLOGIC LOG ☒ GEOPHYSICAL LOG _____
 CASING STRING(S) C=CASING S=SCREEN

0 00'	4 21'	C1	-	-
4 21'	10 55'	S1	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

CASING C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed

 SCREEN S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0 010" wire wrap screen
 0 25' welded bottom cap

 CENTRALIZERS Type 304 stainless steel
 6 62' - 7 77'

 FILTER MATERIAL 32-42 silica sand
 3 00' - 11 00'

 CEMENT Portland Type I
 0 00' - 2 00'

 OTHER 3/8" bentonite pellets
 2 00' - 3 00'
 19.20' - 11.00'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE 1986	TIME	DATE 1986	TIME
DRILLING 7 1/2" auger	9/4	1429	9/4	1530
GEOPHYS LOGGING	—	—	—	—
CASING 2" stainless	9/4	1722	9/4	1724
FILTER PLACEMENT	9/4	1724	9/4	1730
CEMENTING	9/5	1020	9/5	1033
DEVELOPMENT	9/12	1307	9/12	1307
OTHER Bentonite	9/4	1730	9/4	1731
	9/4	1715	9/4	1720

WELL DEVELOPMENT

See Well Development Summary Sheet

COMMENTS

No water encountered during drilling

Top of stainless steel casing 1 65'

Cave from TD to 19.20'

INDEX OF DATA

Boring No 21-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdiograph

Project Rocky Flats Plant		LOG OF BORING NO. 21-86	
Date Drilled 11/10/86 - 11/14/86		Coordinates N 37909 8 E 19399 1	
Boring Method Hollow Stem Auger/NC Core		Ground Surface Elevation 5991 11'	

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Foot) 20 40	Water Content (%) 20 40	Other Tests
	0			<p style="text-align: center;">ROCKY FLATS ALLUVIUM</p> <p>0 0-4.0'-Sample Recovered 0 0/4.0'=0% CLAY moderate brown (5YR 4/4), abundant sand, fine to coarse gravels and small cobbles, moist</p> <p>4.0-8.0'-Sample Recovered 0.8/4 0'=20% CLAY moderate brown (5YR 4/4) to light brown (5YR 5/6), fine to medium- grained sand, some medium to coarse gravel, trace of small cobbles, moist</p> <p>8 0-10.5'-Sample Recovered 0 7/2.5'=28% CLAY same as above with some dusky yellowish brown (10YR 2/2) top soil, disturbed; moist.</p> <p>10.5-13.0'-Sample Recovered 0.8/2 5'=32% CLAY. moderate brown (5YR 4/4), sand, gravel and small cobbles; moist</p> <p>13.0-15.0'-Sample. Recovered 0.7/2.0'=35%. CLAY: same as above; moist.</p> <p style="text-align: center;">ARAPAHOE FORMATION</p> <p>15.0-20.5'-Sample. Recovered 4 5/5.5'=82%. CLAYSTONE dark yellowish orange (10YR 6/6); mica- ceous clay with trace of fine gravel and some sand- rich intervals, moist.</p>			
	20						

Remarks	Logged by L Pivonka	Checked by <i>[Signature]</i>
Project No 106P06222	Hydro-Search, Inc.	Page 1 of 4

Project

Rocky Flats Plant

LOG OF BORING NO.

21-86

Date Drilled 11/10/86 - 11/14/86

Coordinates N 37909 8 E 19399 1

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5991 11'

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Foot)		Water Content (%)		Other Tests
					20	40	20	40	
	20			20 5'-23.0'-Sample Recovered 2 5/2 5'=100% CLAYSTONE dark yellowish orange (10YR 6/6), light olive gray (5Y 6/1), greasy, micaceous, trace of fine-grained sand, moist.					
				23 0'-25 5'-Sample Recovered 2.0/2.5=80% CLAYSTONE same as above except trace of rounded coarse white sandstone gravel and rounded quartz- ite gravel, moist					
	25			25 5'-28.0'-Sample Recovered 2.1/2 5'=84% CLAYSTONE: dark yellowish orange (10YR 6/6) to light olive gray (5Y 6/1), greasy claystone with trace of some fine sand intermixed clay; moist.					
				28 0'-30.5'-Sample. Recovered 2.1/2.5'=84% CLAYSTONE same as above; damp					
	30			30.5'-32.5'-Sample. Recovered 2 0/2.0'=100% SANDSTONE light olive gray (5Y 6/1); dark yellow- ish orange (10YR 6/6); some clay and trace of MnO partings; moist.					
				32.5'-35.0'-Sample. Recovered 2.5/2.5'=100% CLAYSTONE: dark yellowish orange (10YR 6/6) to light olive gray (5Y 6/1); some fine-grained sand; inter- bedded, 30% sand; moist.					
	35			35.0'-40.0'-Sample. Recovered 5.0/5.0'=100% SANDSTONE: dark yellowish orange (10YR 6/6) to light olive gray (5Y 6/1), clay bearing fine-grained; varying amounts of clay up to 30%; wet.					
	40								

Remarks

Logged by L Pivonka

Checked by *[Signature]*Project No
106P06222

Hydro-Search, Inc.

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Project		Rocky Flats Plant		LOG OF BORING NO.				21-86
Date Drilled		11/10/86 - 11/14/86		Coordinates		N 37909 8 E 19399 1		
Boring Method		Hollow Stem Auger/NC Core		Ground Surface Elevation		5991 11'		

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Foot)		Water Content (%)		Other Tests
					20	40	20	40	
	40			40 0'-45 0'-Sample Recovered 5 0/5 0'=100% SANDSTONE medium dark gray (N 4/0), clay-rich, up to 35% clay, fine- grained, moist to wet					
	45			45.0-50.0'-Sample Recovered 5.0/5 0'=100% SANDSTONE same as above but less clay (< 20%), trace of organic carbon fossils; moist to wet					
	50			50.0-55.0'-Sample Recovered 4.2/5 0'=84% SANDSTONE medium dark gray (N 4/0), fine-grained; 15% clay/silt content, trace charcoal wood fossils; moist to wet					
	55			55.0-60.0'-Sample. Recovered 5.0/5.0'=100% SANDSTONE: same as above but more clay-rich (20-30%); moist to wet.					
	60								

Remarks	Logged by L Pivonka	Checked by <i>[Signature]</i>
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Project No 106P06222	Hydro-Search, Inc.	Page 3 of 4
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Project

Rocky Flats Plant

LOG OF BORING NO.

21-86

Date Drilled 11/10/86 - 11/14/86

Coordinates N 37909 8 E 19399 1

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5991 11'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Foot)		Water Content (%)		Other Tests
					20	40	20	40	
	60			60.0-65.0'-Sample. Recovered 5.0/5.0'=100% SANDSTONE, medium dark gray (N 4/0), fine-grained with clay interlaminae; some CaCO ₃ in the lower 3.0'; moist to wet					
	65			65.0-67.0'-Sample. Recovered 2.0/2.0'=100% SANDSTONE medium dark gray (N 4/0); fine-grained; increasing clay content downward to 50%; clay at bottom (moist to wet).					
	70			67.0-69.5'-Sample. Recovered 2.5/2.5'=100%. CLAYSTONE medium dark gray (N 4/0), fine-grained sandstone interlaminae, some leaf fossils and trace grayish orange (10YR 7/4) mottles; moist to wet					
	75			69.5-73.0'-Sample Recovered 3.5/3.5'=100% SANDY CLAYSTONE medium dark gray (N 4/0); up to 50% fine-grained sand intermixed; moist					
	80			73.0-78.0'-Sample Recovered 5.0/5.0'=100%. CLAYSTONE: medium dark gray (N 4/0), some fine- grained sand; trace gray- ish orange (10YR 7/4) mottles; moist.					
				TOTAL DEPTH. 78.0'					

Remarks

Logged by L. Pivonka

Checked by *[Signature]*

Project No

106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS

N 37909 8 E 19399.1

ELEVATION GROUND LEVEL 5991 11'

TOP OF CASING 5993 21'

DRILLING SUMMARY

TOTAL DEPTH Well 67 25' Hole 78 00'

BOREHOLE DIAMETER 0 00' - 30 50' 7 1/4"

30 50' - 78 00' 4 3/4"

DRILLER Boyles Brothers Drilling Co

15865 W 5th Avenue

Golden, CO (Jim Horn)

RIG Mobile B-57

BIT(S) 0.00' - 30.50', Blade bit

30 50' - 78 00' Coring bit

DRILLING FLUID None

SURFACE CASING 5" x 31 53' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG ☒ GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

0 00' 29 93' C1

0 00' 35 00' C2

35 00' 67 24' S1

CASING C1 5" I D steel surface casing

C2 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed

SCREEN S1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrapped screen, 0.25' welded bottom cap

CENTRALIZERS Type 304 stainless steel
49 84' - 51 06'FILTER MATERIAL 32-42 silica sand
34.00' - 68.00'CEMENT Portland Type I
0.00' - 32.00'OTHER 3/8" bentonite pellets
32 00' - 34 00'
68 00' - 78 00'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING 7 1/4" auger	1986		1986	
	11/10	1105	11/11	1414
	11/13	1400	11/14	1150
	11/17	1445	11/18	0943
GEOPHYS LOGGING	—	—	—	—
CASING 5" steel	11/11	1416	11/11	1453
	11/18	1053	11/18	0943
FILTER PLACEMENT	11/18	1047	11/18	1144
CEMENTING	11/18	1253	11/18	1315
DEVELOPMENT	11/19	0920	11/25	0945
OTHER Bentonite	11/18	1144	11/18	1151
	11/18	1037	11/18	1047
	11/17	1125	11/17	1426

WELL DEVELOPMENT

See Well Development Summary Sheet

COMMENTS

No water encountered during drilling

Top of stainless steel casing 2 10'

LOCATION Rocky Flats Plant
PERSONNEL L. Pivonka

106P06222

PROJECT

INDEX OF DATA

Boring No 22-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdriograph

Project Rocky Flats Plant

LOG OF BORING NO. 22-86

Date Drilled 9/8/86

Coordinates N 37734 9 E 21307.7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5976.81

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ROCKY FLATS ALLUVIUM					
				0-3 0'-Sample Recovered 1 3/3.0'=43% CLAY grayish brown (5YR 3/2) to dusky brown (5YR 3/2), some quartzite pebbles, poorly sorted, soft, unconsolidated; wet					
	2.5			3 0-5 0'-Sample Recovered 2 0/2 0'=100% GRAVEL dark reddish brown (10YR 3/4) to grayish olive (10Y 4/2) granite and quartzite pebbles and cobbles, some sand, silt and clay, poorly sorted, unconsolidated, wet					
	5			5 0-7 0'-Sample Recovered 1 3/2 0'=65% GRAVEL pale olive (10Y 3/2) granitic pebbles and coarse to fine-grained sand, silty, trace clay, poorly sorted, calcareous, damp					
	7.5			7 0-10 0'-Sample Recovered 0 6/3 0'=20% GRAVEL pale olive (10Y 3/2) granitic pebbles and cobbles; some coarse to fine-grained sand and silt, trace clay, poorly sorted; angular, damp					
	10								

Remarks

Logged by T Murphy

Checked by *[Signature]*



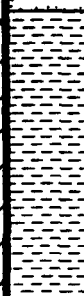
Project No.

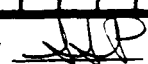
106P06222

Hydro-Search, Inc.

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Project Rocky Flats Plant			LOG OF BORING NO. 22-86			
Date Drilled 9/8/86			Coordinates N 37734.9 E 21307 7			
Boring Method Hollow Stem Auger			Ground Surface Elevation 5976 81			

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	10			10 0-12.0'-Sample Recovered 2 0/2 0'=100% 10 0-11 0' GRAVEL Same as above, wet		▼	
				ARAPAHOE FORMATION			
	12 5			11 0-12.0' SANDSTONE medium light gray (N 6), medium to fine-grained silty sand with some clay, few dark yellowish orange (10YR 6/6) iron staining, moderately sorted, firm, moist			
	15			12 0-14 0'-Sample Recovered 2 0/2 0'=100% SANDSTONE medium light gray (N 6), medium to fine-grained sand and silty sand, increased iron staining, clayey layers at 12 9 and 13 4', well sorted, firm, moist			
	17 5			14 0-16 0'-Sample Recovered 2 0/2 0'=100% SANDSTONE medium light gray (N 6), medium to fine-grained sand and silty sandstone with interbedded claystone, increase in clay content, slightly calcareous fractures at 14 4', moderately sorted, firm, moist			
				16 0-18 0'-Sample Recovered 2 0/2 0'=100% SANDSTONE medium light gray (N 6) interbedded sandstone and claystone, increase in dark yellowish orange iron staining (10YR 6/6), increase in clay content, moderately sorted, firm; moist			
	20			18.0-19.0'-Sample. Recovered 1.0/1 0'=100% CLAYSTONE greenish gray (5GY 6/1) to medium light gray (N 6), with interbedded fine-grained, silty, clayey sand, firm, moist			

Remarks	Logged by T Murphy	Checked by 
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Project No. 106P06222	Hydro-Search, Inc.	Page 2 of 3
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Project Rocky Flats Plant

LOG OF BORING NO. 22-86

Date Drilled 9/8/86

Coordinates N 37734 9 E 21307 7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5976 81

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			19 0-21 0'-Sample Recovered 2 0/2 0'=100% CLAYSTONE Same as above, moist					
				21 0-23 0'-Sample Recovered 2 0/2 0'=100% CLAYSTONE dark gray (N 4) to greenish gray (5GY 6/1), with interbedded fine-grained, clayey sandstone, some iron staining, firm, moist					
	22 5			23 0-24 0'-Sample Recovered 1 0/1 0'=100% CLAYSTONE dark gray (N 4) to greenish gray (5GY 6/1), with minor interbedded fine-grained sandstone, firm, moist					
				24 0-26 0'-Sample Recovered 2 0/2 0'=100% CLAYSTONE dark gray (N 4) to greenish gray (5GY 6/1), with interbedded fine-grained medium to dark gray (N 5 to N 6) sandstone, firm, damp					
	25								
				TOTAL DEPTH 26 0'					
	27 5								
	30								

Remarks

Logged by T Murphy

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Project No.

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Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS

N 37734 9 E 21307 7

ELEVATION GROUND LEVEL 5976 81'

TOP OF CASING 5978 05'

DRILLING SUMMARY

TOTAL DEPTH Well 11 20' Hole 26 00'

BOREHOLE DIAMETER 7 1/4"

DRILLER Boyles Brothers Drilling Co

15865 W 5th Avenue

Golden, CO (Dave Jarvie)

RIG Mobile B-57

BIT(S) T5

DRILLING FLUID None

SURFACE CASING 5" x 4' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

[illegible]

CASING C1 2" I D Sch 5 type 316 stain-
less steel, threaded and flush
jointed.

SCREEN SI 2" I.D. Sch. 5 type 316 stain-
less steel, threaded and flush
jointed, 0.010" wire wrap screen
0 25' welded bottom cap

CENTRALIZERS Type 304 stainless steel
6.10' - 7.35'

FILTER MATERIAL 32-42 silica sand
2 50' - 11 40'

CEMENT Portland Type I
0 00' - 2 00'

OTHER 3/8" bentonite pellets
2 00' - 2 50'
11 40' - 22 60'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	9/8	1000	9/8	1629
GEOPHYS LOGGING	—	—	—	—
CASING				
2" stainless	9/8	1734	9/8	1735
FILTER PLACEMENT	9/8	1738	9/8	1742
CEMENTING	9/8	1748	9/8	1800
DEVELOPMENT	9 / 12	1620	9 / 19	1345
OTHER				
Bentonite	9 / 8	1742	9/8	1748
	9/8	1723	9/8	1725

WELL DEVELOPMENT

See Well Development Summary Sheet

COMMENTS

Water encountered at 10 5' during drilling

Top of stainless steel casing 1.24'

Cave from TD to 22 57'

INDEX OF DATA

Boring No 23-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project Rocky Flats Plant

LOG OF BORING NO. 23-86

Date Drilled 9/11/86, 9/19/86, 9/22/86, 9/23/86 Coordinates N 37355 0 E 21154 4

Boring Method Hollow Stem Auger/NC core Ground Surface Elevation 5981 18

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ARTIFICIAL FILL					
				0-2 5'-Sample Recovered 1 5/2 5'=60% Pale GRAVEL reddishbrown (10R 5/4) to light olive gray (5Y 5/2) sand, silt and pebbles, some quartzite cobbles, calcareous, poorly sorted, angular, unconsolidated, dry					
				2 5-5 0'-Sample Recovered 1 2/2 5'=48% GRAVEL yellowish gray- (5Y 8/4) sand, silt and pebbles, calcareous, poorly sorted, angular, damp					
				5 0-7 0'-Sample Recovered 0 7/2 0'=35% GRAVEL pale olive (10Y 6/2) granite and quartzite pebbles, some sand, trace clay and silt, calcareous, poorly sorted, compacted, damp					
				7 0-9.5'-Sample Recovered 1.7/2 5'=68%					
	10			7 0-8.2' GRAVEL Same as above; damp					
				ARAPAHOE FORMATION					
				8 2-9 5' CLAYSTONE pale olive (10Y 6/2), silty, calcite along fractures at 8 5', 9.0', and 9.5', some dark yellowish orange (10YR 6/6) staining, firm, damp					
				9.5-12 0'-Sample Recovered 2 5/2 5'=100% CLAYSTONE yellowish gray to greenish gray (5Y 7/2 to 5GY 6/1), sandy and silty in upper 1 5' increasing in clay content with depth, some dark yellowish orange (10YR 6/6) iron staining, ironstone at 10.5', calcareous layers at 9 5' and 10 7', firm, damp					
	15								
	20								

Remarks

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Project. Rocky Flats Plant

LOG OF BORING NO. 23-86

Date Drilled 9/11/86, 9/19/86, 9/22/86, 9/23/86 Coordinates N 37355 0 E 21154 4

Boring Method Hollow Stem Auger/NC core Ground Surface Elevation 5981 18

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			12.0-17 0'-Sample Recovered 5.0/5 0'=100% CLAYSTONE light olive gray (5Y 5/2) to olive gray (5Y 3/2), silty, calcareous layer at 13 5', firm, damp.					
				17 0-22 0'-Sample Recovered 5 0/5 0'=100% CLAYSTONE light olive gray (5Y 5/2), silty, trace calcite at 18 1', trace dark yellowish orange (10YR 6/6) iron staining, firm, damp					
	25			22 0-27 0'-Sample Recovered 5 0/5 0'=100% CLAYSTONE light olive gray to olive gray (5Y 5/2 to 5Y 3/2), silty, some dark yellowish orange (10YR 6/6) iron staining, some black organic fragments, firm, damp					
				27 0-32 0'-Sample Recovered 5 0/5 0'=100% CLAYSTONE medium dark gray (N 4), silty, firm, damp					
	30			33.0-38 0'-Sample Recovered 5.0/5 0'=100% RQD 4 9/5.0'=98% CLAYSTONE dusky yellow (5Y 6/4) to light olive gray (5Y 5/2) to medium light gray (N 5), trace silt; some organic fragments; dark yellowish orange (10YR 6/6) mottling in light olive gray areas, no apparent fractures, moderately soft to firm, damp.					
	35			38.0-40 9'-Sample Recovered 2.0/2 9'=69% RQD 2 0/2.0'=100% CLAYSTONE medium light gray (N 5), iron staining at 39 0'; subvertical fracture with iron staining from 39 0' to 39.8'; core has a mottled appearance with yellowish gray (5Y 8/1) stains throughout; firm to moderately soft, damp					
	40								

Remarks Logged by T Murphy

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Project Rocky Flats Plant

LOG OF BORING NO. 23-86

Date Drilled 9/11/86, 9/19/86, 9/22/86, 9/23/86 Coordinates N 37355 0 E 21154 4

Boring Method Hollow Stem Auger/NC core Ground Surface Elevation 5981 18

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)	Water Content (%)		Other Tests
						20	40	
	40			40 9'-45 9'-Sample Recovered 2.8/5.0'=56% RQD 1 6/2 8'=57% CLAYSTONE olive gray (5Y 4/1), trace silt, some organic fragments; vertical limonite filled fracture from 40 9' to 42 5', horizontal limonite filled fracture at 41 9', firm to moderately soft, damp				
	45			45 9'-50 9'-Sample Recovered 4 8/5.0'=96% RQD 4 2/4.8'=86% 45.9'-50.2' CLAYSTONE medium (N5) to medium dark gray (N4) Highly fractured interval with limonite along fracture planes (2 mm wide) from 48 3' to 49.6', top 4.0' of core has abundant organics (wood fragments), firm, damp				
	50			50 2'-50.9' CLAYSTONE - dusky yellow (5Y 6/4)				
	55			50 9'-55.9'-Sample. Recovered 4 0/5 0'=80% RQD 2 6/4 0'=65% 50.9'-51.5' CLAYSTONE light olive gray (5Y 5/2), heavy limonite along fracture planes. 51.5'-52 6'. CLAYSTONE medium dark gray (N4) claystone with interbedded dusky yellow (5Y 6/4) clayey siltstone 52 6'-55 9' CLAYSTONE medium dark gray (N4), silty, occasional subvertical fracture with limonite stain (up to 0 7' long); firm; damp.				
	60			55.9'-60.9'-Sample Recovered 3.8/4 6'=83% RQD 2.5/3 8'=66% CLAYSTONE olive gray (5Y 3/2) to medium dark gray (N4); silty; trace iron staining at top of core, firm; damp				

Remarks Logged by T Murphy

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Project Rocky Flats Plant

LOG OF BORING NO. 23-86

Date Drilled 9/11/86, 9/19/86, 9/22/86, 9/23/86 Coordinates N 37355 0 E 21154 4

Boring Method Hollow Stem Auger/NC core Ground Surface Elevation 5981 18

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	60			60 9-65.5'-Sample Recovered 4 6/4.6'=100% RQD 4 3/4 6'=93% SILTSTONE dark gray (N 3) grading downward into dark greenish gray (5GY 4/1) clayey siltstone, some organic wood fragments, firm; damp					
	65			65 5-70 5'-Sample Recovered 5.0/5 0'=100% RQD 3 7/5 0'=74% SILTSTONE dark greenish gray (5GY 4/1), clayey, trace very fine-grained sand, dark gray (N3) clayey siltstone from 68 5 to 70 5', calcareous layer at 66 5 with slight dark yellowish orange (10YR 6/6) iron stains, firm, damp					
	70			70 5-75 5'-Sample Recovered 2 5/5 0'=50% RQD 0 0/2 5'=0% CLAYSTONE dark greenish gray (5GY 4/1); silty, trace very fine-grained sand, highly fractured, some organic fragments in vertical fractures, crumbly, damp					
	75			75.5-80 5'-Sample. Recovered 4.8/5.0'=96% RQD 2 3/4 8'=48% SILTSTONE dark greenish gray (5GY 4/1), some clay and very fine-grained sand; few organics; very pale orange (10YR 8/2) calcareous clay layer at 77 5', firm; damp					
	80								

Remarks

Logged by T Murphy

Checked by *[Signature]*

Project No.

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Hydro-Search, Inc.

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Project. Rocky Flats Plant

LOG OF BORING NO. 23-86

Date Drilled 9/11/86, 9/19/86, 9/22/86, 9/23/86 Coordinates N 37355.0 E 21154 4

Boring Method Hollow Stem Auger/NC core Ground Surface Elevation 5981 18

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	80			80 5-85 5'-Sample. Recovered 4 6/5 0'=92% RQD 2 7/4 6'=59% SILTSTONE dark gray (N 3) to dark greenish gray (5GY 4/1), interbedded 0 1' to 0 3' beds of sandy siltstone, convoluted bedding in places, occasional clayey siltstone, firm, damp					
	85			85 5-90 5'-Sample Recovered 5 0/5 0'=100% RQD 1 4/5 0'=28% SILTSTONE dark gray (N 3) to dark greenish gray (5GY 4/1), interbedded sandy siltstone beds (0 5' thick, occasional clayey siltstone layers, organics throughout, calcareous concretions from 87.8' to 88 4', firm, damp					
	90			90.5-95.5'-Sample Recovered 5 0/5 0'=100% RQD 1 2/5 0'=24% SILTSTONE dark gray (N 3), interbedded sandy siltstone and clayey siltstone beds, sand is very fine-grained, vertical fracture from 92 5'-95 5' due to drilling; crumbly, firm, damp					
	95			95 5-100 5'-Sample Recovered 4 8/5 0'=96% RQD 3 8/5 0'=76% SILTSTONE dark gray (N 3), trace very fine-grained sand throughout, some organics, laminated, light olive gray (5Y 6/1) mottling around organic fragments, firm, damp					
	100								

Remarks

Logged by T Murphy

Checked by *[Signature]*

Project No.

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Hydro-Search, Inc.

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Project Rocky Flats Plant

LOG OF BORING NO. 23-86

Date Drilled 9/11/86, 9/19/86, 9/22/86, 9/23/86 Coordinates N 37355 0 E 21154 4

Boring Method Hollow Stem Auger/NC core Ground Surface Elevation 5981 18

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	100			100 5'-105 5'-Sample Recovered 5 0/5 0'=100% RQD 2 1/5 0'=42% SILTSTONE dark gray (N 3), sandy, interbedded silty sandstone beds at 102 6' and 103 8' (approximately 0 4' thick) Sandstone layers consist of medium gray (N 5) very fine-grained, silty sand, moderately sorted, convoluted bedding characteristic of interbedded siltstone and sandstone layers, some calcareous concretions in sandy siltstone layers, abundant organics, firm to hard, damp					
	105			105 5'-110 5'-Sample Recovered 3 2/5 0'=64% RQD 1 9/3 2'=59% SANDSTONE dark gray (N 3), very fine-grained, silty, clayey, lower 1 2' of core is clayey siltstone, soft to firm, damp					
	110			110.5'-116.5'-Sample Recovered 4 6/5.0'=92% RQD 3.6/4 6'=78% 110.5'-113 3' SILTSTONE dark gray (N 3), clayey, increasing sand content through interval					
				113 3'-115 5' SANDSTONE medium gray (N 5), fine to very fine-grained, occasional clay-filled vertical fracture, moderately sorted; firm, damp					
	115			115 5'-120 5'-Sample Recovered 5.0/5.0'=100% RQD 4 0/5 0'=80% 115 5'-116 5' SANDSTONE medium gray (N 5), fine to very fine-grained, moderately sorted, firm, damp Gradational change to siltstone at 116 5'					
				116 5'-120 5'. SILTSTONE dark gray (N 3), very fine-grained, sandy, some clay, well sorted, organic fragments in subvertical fractures and horizontal layers, subvertical fractures have slickensides, fractures are 1 0' to 1.5' apart					
	120								

Remarks

Logged by T Murphy

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Project Rocky Flats Plant

LOG OF BORING NO. 23-86


Date Drilled 9/11/86, 9/19/86, 9/22/86, 9/23/86 Coordinates N 37355 0 E 21154 4

Boring Method Hollow Stem Auger/NC core Ground Surface Elevation 5981 18

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	120			120.5-125 5'-Sample Recovered 5 0/5 0'=100% RQD 3 9/5 0'=78% SILTSTONE dark gray (N 3) to medium gray (N5), clayey, with interbedded sandy siltstone, sand is fine to very fine-grained, moderately sorted, some organic fragments, slickensides along fracture planes					
	125			125 5-130 5'-Sample Recovered 4 8/5 0'=96% RQD 4 2/4 8'=88% SILTSTONE dark gray (N 3) to medium gray (N5), clayey, with occasional interbedded sandy siltstone, occasional light brown (5YR 6/4) calcareous concretions, moderately sorted, firm, damp					
	130								
				TOTAL DEPTH 130 5'					
	135								
	140								

Remarks

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Project No.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS _____
N 37355 0 E 21154 4

ELEVATION	GROUND LEVEL	<u>5981 18'</u>
	TOP OF CASING	<u>5981 91'</u>

DRILLING SUMMARY

TOTAL DEPTH Well 117 00' Hole 130 50'
BOREHOLE DIAMETER 0 00' - 32 00' 7 1/2"
32 00' - 130 50' 5 5/8"
DRILLER Boyles Brothers Drilling Co
15865 W 5th Avenue, Golden, CO
(Dave Jarvie)
RIG Mobile B-57
BIT(S) 0 00' - 32 00' T5
32 00' - 130 50' Carbide bit
DRILLING FLUID 0 00' - 32 00' None
32 00' - 130 50' air/water mist
SURFACE CASING 5" x 32 50' steel w/ lock-
ing cap

WELL DESIGN

[illegible]

CASING C1 5" I D steel surface casing
C2 2" I D Sch 5 type 316 stain-
less steel, threaded and flush
jointed

SCREEN S1 2" I D Sch 5 type 316 stain-
less steel, threaded and flush
jointed, 0.010" wire wrap screen,
0 25' welded bottom cap

CENTRALIZERS None (see comments)

FILTER MATERIAL 32-42 silica sand
112 00' - 117 50'

CEMENT Portland Type I
0.00' - 111.00'

OTHER 3/8" bentonite pellets
111 00' - 112.00'
 117 50' - 130 50'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
<u>7 1/2" auger</u>	<u>9/11</u>	<u>1500</u>	<u>9/11</u>	<u>1800</u>
<u>NC core</u>	<u>9/19</u>	<u>1000</u>	<u>9/23</u>	<u>1500</u>
<u>Reaming</u>	<u>9/26</u>	<u>1217</u>	<u>9/26</u>	<u>1541</u>
GEOPHYS LOGGING	—	—	—	—
CASING				
<u>5" steel</u>	<u>9/12</u>	<u>1000</u>	<u>9/12</u>	<u>1115</u>
<u>2" stainless</u>	<u>9/26</u>	<u>1637</u>	<u>9/26</u>	<u>1650</u>
FILTER PLACEMENT	<u>9/26</u>	<u>1738</u>	<u>9/26</u>	<u>2021</u>
CEMENTING	<u>9/27</u>	<u>0830</u>	<u>9/27</u>	<u>1037</u>
DEVELOPMENT	<u>10/1</u>	<u>1200</u>	<u>10/1</u>	<u>1200</u>
OTHER				
<u>Bentonite</u>	<u>9/26</u>	<u>2021</u>	<u>9/26</u>	<u>2130</u>
	<u>9/26</u>	<u>1542</u>	<u>9/26</u>	<u>1545</u>
<u>Packer testing</u>	<u>9/23</u>	<u>1500</u>	<u>9/26</u>	<u>1217</u>
<u>Cementing 5"</u>	<u>9/12</u>	<u>1130</u>	<u>9/12</u>	<u>1225</u>
<u>steel</u>				

WELL DEVELOPMENT

See Well Development Summary Sheet

COMMENTS

No water encountered during drilling

Top of stainless steel casing 0.73'

Built well in NC rod. no centralizers used

Protective casing and stainless steel
casing were bent and had to be cut New
top of stainless steel casing 0 08'

INDEX OF DATA

Boring No 24-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data
and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project Rocky Flats Plant

LOG OF BORING NO. 24-86

Date Drilled 9/12/86


Coordinates N 37354.8 E 21172.8

Boring Method Hollow Stem Auger

Ground Surface Elevation 5980.45

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ARTIFICIAL FILL					
				0-2.5'-Sample Recovered 2 0/2 5'=80% GRAVEL yellowish gray (5Y 7/2) to light olive gray (5Y 5/2) granitic pebbles and coarse sand, some silt, trace clay, base of sample is grayish brown (5YR 3/2), poorly sorted, soft, dry					
	5			2 5-5 0'-Sample Recovered 0 9/2 5'=36% GRAVEL yellowish gray (5Y 7/2) to light olive gray (5Y 5/2) granite and quartzite pebbles, pale greenish yellow (10Y 8/2) sandy matrix, poorly sorted, angular, crumbly dry					
				5 0-7 0'-Sample Recovered 0 0/2 0'=0% Large boulder prevented sample recovery					
	10			7 0-12 0'-Sample Recovered 5.0/5 0'=100%					
				7 0-7 2' GRAVEL Same as above, dry					
				ARAPAHOE FORMATION					
	15			7 2-12 0' CLAYSTONE. pale olive (10Y 6/2) to greenish gray (5GY 6/1), silty, some fine-grained sand and silty sand stringers at 7 8', sand is slightly calcareous, claystone contains dark yellowish orange (10YR 6/6) iron staining; calcareous pockets along fractures throughout sample, firm, damp					
				TOTAL DEPTH 12 0'					
	20								

Remarks Logged by T Murphy

Checked by Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS _____
 N 37354 8 E 21172.8

 ELEVATION GROUND LEVEL 5980 45'
 TOP OF CASING 5982 07'

DRILLING SUMMARY

 TOTAL DEPTH Well 7 45' Hole 12 00'
 BOREHOLE DIAMETER 7 1/2"
 DRILLER Boyles Brothers Drilling Co.
 15865 W 5th Avenue
 Golden, CO (Dave Jarvie)
 RIG Mobile B-57
 BIT(S) T5
 DRILLING FLUID None
 SURFACE CASING 5" x 4" steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG ☒ GEOPHYSICAL LOG _____

CASING STRING(S) C=CASING S=SCREEN

0 00'	2.95'	CI	-
2.95'	7.45'	SI	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

CASING CI 2" I P Sch 5 type 316 stainless steel, threaded and flush jointed.

 SCREEN SI 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed 0 010" wire wrap screen
 0 25' welded bottom cap

 CENTRALIZERS Type 304 stainless steel
 4 34' - 5 59'

 FILTER MATERIAL 32-42 silica sand
 2 50' - 7 70'

 CEMENT Portland Type I
 0 00' - 2 00'

 OTHER 3/8" bentonite pellets
 2.00' - 2.50'
 7.70' - 11 90'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	9/12	1320	9/12	1400
GEOPHYS LOGGING	-	-	-	-
CASING				
2" stainless	9/12	1525	9/12	1526
FILTER PLACEMENT	9/12	1526	9/12	1530
CEMENTING	9/12	1532	9/12	1535
LEVELPMENT	9/16	1650	9/16	1650
OTHER				
Bentonite	9/12	1530	9/12	1532
	9/12	1520	9/12	1525

WELL DEVELOPMENT

See Well Development Summary Sheet

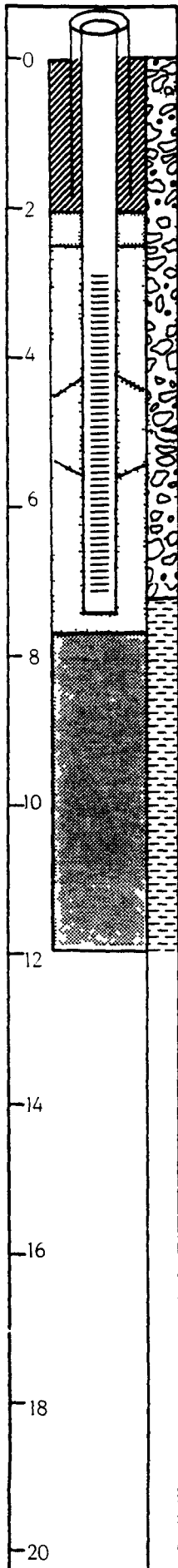
COMMENTS

No water encountered during drilling

Top of stainless steel casing 1.62'

Cave from TD to 11 90'

 LOCATION Golden, CO
 PERSONNEL I Murphy

 PROJECT 106P06222
 Rocky Flats Plant


INDEX OF DATA

Boring No 25-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data
and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

Project Rocky Flats Plant

LOG OF BORING NO.

25-86

Date Drilled 9/13/86 - 9/17/86

Coordinates N 37426.3 E 21726.5

Boring Method NC Core

Ground Surface Elevation 5974.45

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ARTIFICIAL FILL					
				0-2 0'-Cuttings GRAVEL granite and quartzite pebbles and large cobbles, dry					
				2 0-9 0'-Cuttings GRAVEL pale yellowish brown (10YR 6/2), clayey, some silt and sand, 50% fines, dry to slightly damp					
	5			9 0-11 0'-Cuttings CLAY gray orange (10YR 7/4), sandy and silty, caliche stringers, 1-2% quartzite pebbles, damp					
				11 0-13 0'-Cuttings CLAY gray orange (10YR 7/2), gravelly, silty; 20% quartzite pebbles, caliche stringers, damp					
	10			13 0-17 0'-Cuttings CLAY Same as above, light olive brown (5Y 5/6), damp					
	15								
				ARAPAHOE FORMATION					
				17 0-19 5'-Cuttings CLAYSTONE. moderate yellowish brown (10YR 5/4), sub-plastic, damp					
				19 5-20.0'-Cuttings CLAYSTONE grayish brown (5YR 3/2), plastic, moist					
	20								

Remarks

Logged by T Gulliver & T Murphy

Checked by

Project No.

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Hydro-Search, Inc.

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25-86

Ground Surface Elevation 5974.45

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Project: Rocky Flats Plant

LOG OF BORING NO.

25-86

Date Drilled 9/13/86 - 9/17/86

Coordinates N 37426.3 E 21726.5

Boring Method NC Core

Ground Surface Elevation 5974.45

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	40								
				41.6-46 6'-Sample Recovered 5 0/5 0'=100% RQD 3 0/5 0'=60% CLAYSTONE. light olive gray (5Y 5/2) to olive gray (5Y 3/2), light brown to dark yellowish orange (10YR 6/6) iron staining, trace silt, ironstone, altered claystone concretions from 46 0-46 6', firm; damp					
	45			46 6-51 6'-Sample Recovered 5 0/5 0'=100% RQD 3 6/5 0'=72% CLAYSTONE light brown (10YR 6/6) grading to medium dark gray (N 4), ironstone from 46.6-47 0', heavy iron staining at 48 0'; high angle fractures with calcite along fracture planes, firm; moist					
	50			51 6-56 6'-Sample. Recovered 5 0/5 0'=100% RQD 4.3/5 0'=86% CLAYSTONE grayish black (N 2) to dark gray (N 3), occasional dark yellowish orange (10YR 6/6) iron staining; some coaly layers and fragments; firm, damp					
	55								
	60			56.6-61.6'-Sample Recovered 5.5/5.0'=100% RQD 3 5/5.0'=57% CLAYSTONE grayish black (N 2); silty; organic wood fragments, fractures due to drilling, firm; damp					

Remarks

Logged by T Gulliver & T Murphy

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Hydro-Search, Inc.

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Project: Rocky Flats Plant				LOG OF BORING NO. 25-86			
Date Drilled 9/13/86 - 9/17/86				Coordinates N 37426.3 E 21726.5			
Boring Method NC Core				Ground Surface Elevation 5974.45			

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	60			61.6-66 6'-Sample Recovered 4 0/5 0'=80% RQD 3 4/4 0'=92% CLAYSTONE light olive gray (5Y 5/2), silty, occasional very fine-grained sandstone laminations at 63 5', cal- careous at 63 0', hard, dry to damp					
	65			66 6-71 6'-Sample Recovered 5.0/5 0'=100% RQD 5 0/5 0'=100% CLAYSTONE grayish black (N 3), thin interbedded silty claystone and clayey siltstone, highly fractured with numerous subvertical slickensides, crumbly to firm, damp.					
	70			71 6-74 0'-Sample Recovered 0 0/2 4'=0%					
	75			74 0-79 0'-Sample Recovered 5.0/5 0'=100% RQD 4.2/5 0'=85% SANDSTONE dark greenish gray (5GY 4/1), very fine-grained; silty; some clay; laminations of siltstone, convoluted bedding; moderately sorted; firm; damp.					
	80			79.0-81.1'-Sample Recovered 2 1/2.1'=100% RQD 1.3/2.1'=62%. SANDSTONE. Same as above, damp					

Remarks		Logged by T Gulliver & T Murphy	Checked by <i>[Signature]</i>
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Project: Rocky Flats Plant				LOG OF BORING NO.				25-86	
Date Drilled 9/13/86 - 9/17/86				Coordinates N 37426.3 E 21726.5					
Boring Method NC Core				Ground Surface Elevation 5974.45					

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch) 20 40	Water Content (%) 20 40	Other Tests
	80			81 1-82 6'-Sample Recovered 1 3/1 5'=87% RQD 0 6/1.3'=46% SANDSTONE Same as above, some black coal lenses, firm, damp			
	85			82 6-85 6'-Sample Recovered 3 0/3 2'=94% RQD 1.3/3 0'=43% SILTSTONE grayish black (N 3), alternating laminations of very fine-grained sandy siltstone and clayey siltstone, very fine coaly lenses, thinly bedded, some convoluted bedding, firm; dry to damp			
	90			85.5-89 8'-Sample Recovered 2 4/4 2'=57% RQD 0 0/2 4'=0% SILTSTONE. Same as above, dry to damp			
				TOTAL DEPTH - 89.8'			
	95						
	100						

Remarks	Logged by T Gulliver & T Murphy	Checked by <i>[Signature]</i>
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WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS _____
 N 37426 3 E 21726 5

 ELEVATION GROUND LEVEL 5974 45'
 TOP OF CASING 5976 55'

DRILLING SUMMARY

 TOTAL DEPTH Well 82 00' Hole 89 80'
 BOREHOLE DIAMETER 0 00' - 38 50' 7 1/4"
 38 50' - 89 80' 3 3/4"
 DRILLER Boyles Brothers Drilling Co
 15865 W 5th Avenue
 Golden, CO (Dave Jarvie)
 RIG Mobile B-57
 BIT(S) 0 00' - 38 56' Blade bit, 38 56' -
 89 80' Carbide bit
 DRILLING FLUID 0.00' - 38 50' None, 38.50'
 - 89 80' air/water mist
 SURFACE CASING 5" x 41' steel w/ locking
 cap

WELL DESIGN

 BASIS GEOLOGIC LOG X GEOPHYSICAL LOG _____
 CASING STRING(S) C=CASING S=SCREEN
 0 00' 38 50' C1 _____
 0 00' 59 90' C2 _____
 59.90' 82.00' S1 _____

 CASING C1 5" I D steel surface casing
 C2 2" I D Sch. 5 type 316 stain-
 less steel, threaded and flush
 jointed.

 SCREEN S1 2" I.D. Sch. 5 type 316 stain-
 less steel, threaded and flush
 jointed, 0 010" wire wrap screen,
 0 25' welded bottom cap

CENTRALIZERS None (see comments)

 FILTER MATERIAL 32-42 silica sand
 66 10' - 83 60'

 CEMENT Portland Type I
 0 00' - 64 00'

 OTHER 3/8" bentonite pellets
 64 00' - 66 10'
 83 60' - 84 60'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/4" auger	8/26	1401	8/27	1330
NC core	9/13	1400	9/16	1700
Reaming	9/17	1030	9/17	1315
GEOPHYS LOGGING	—	—	—	—
CASING				
5" steel	8/27	1353	8/27	1421
2" stainless	9/17	1537	9/17	1545
FILTER PLACEMENT	9/17	1526	9/17	1804
CEMENTING	9/18	0904	9/18	1010
LEVELPMENT	9/30	1430	10/1	0945
OTHER				
Bentonite	9/17	1805	9/17	1816
	9/17	1505	9/17	1506
Cementing 5" steel	8/27	1540	8/27	1606

WELL DEVELOPMENT

See Well Development Summary Sheet

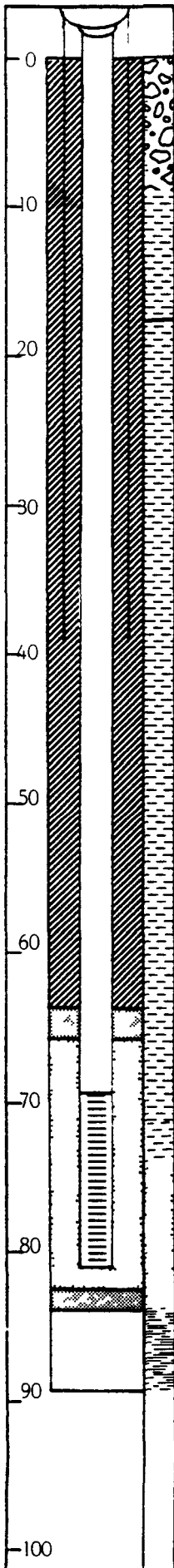
COMMENTS

No water encountered during drilling

Top of stainless steel casing 2.10'

Cave from TD to 84 60'

 LOCATION Golden, CO
 PERSONNEL I. Murphy

 PROJECT 106P06222
 Rocky Flats Plant


INDEX OF DATA

Boring No 26-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project

Rocky Flats Plant

LOG OF BORING NO.

26-86

Date Drilled 8/22/86

Coordinates N 37425.8 E 21737.2

Boring Method

Hollow Stem Auger

Ground Surface Elevation 5974.48

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ARTIFICIAL FILL					
				0-1 5'-Sample Recovered 1 3/1 5'=87% GRAVEL light brown (5YR 6/4) granite and quartzite pebbles and cobbles, sandy, poorly sorted, angular to subangular, dry					
				1.5-4 0'-Sample Recovered 0/2 5'=0%					
	2 5			4 0-7 0'-Sample Recovered 2 6/3 0'=87%					
				4 0-4 5' Same as above, dry					
				4 5-7 0' SAND very pale orange (10YR 8/2) to grayish orange (10YR 7/4), very coarse to fine- grained, some granite and quartzite pebbles and cobbles, silty, grades into dark yellow orange (10YR 6/6) sand at base of sample, bedding apparent due to size variation, poorly sorted, subangular to angular, damp					
	5			7 0-9 0'-Sample Recovered 0 0/2 0'=0%					
				9 0-12 0'-Sample Recovered 3 0/3 0'=100%					
				9 0-9 5' Same as above, damp					
	7 5			ARAPAHOE FORMATION					
				9.5-12.0' CLAYSTONE light olive brown (5Y 5/6), some silt, trace sand, sand layers from 10 4-10 7' and 11.4-11 6', sand is very pale orange (10YR 8/2), coarse- grained, moderately sorted, subangular, trace calcareous cement, unconsolidated, soft, wet, clay is firm, moist					
	10								

Remarks

Logged by T Murphy

Checked by

Project No.

106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 26-86

Date Drilled 8/22/86

Coordinates N 37425.8 E 21737.2

Boring Method Hollow Stem Auger

Ground Surface Elevation 5974.48

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	10								
	12.5			12.0-17.0'-Sample Recovered 5.0/5.0'=100% - CLAYSTONE medium dark gray (N4) with grayish orange (10YR 7/4) and pale olive (10YR 6/2) mottling, some silt with very coarse-grained sand lenses less than 0.2' thick, ironstone layer at 12.9-13.2' with calcareous cement, firm, moist					
	15								
	17.5			TOTAL DEPTH 17.0'					
	20								

Remarks Logged by T. Murphy

Checked by *[Signature]*Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS _____

N 37425 8 E 21737.2

ELEVATION GROUND LEVEL 5974 48'

TOP OF CASING 5976 49'

DRILLING SUMMARY

TOTAL DEPTH Well 11 00' Hole 17 00'

BOREHOLE DIAMETER 7 1/2"

DRILLER Boyles Brothers Drilling Co

15865 W 5th Avenue

Golden, CO (Dave Jarvie)

RIG Mobile B-57

BIT(S) Blade bit

DRILLING FLUID None

SURFACE CASING 5' x 5' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG _____

CASING STRING(S) C=CASING S=SCREEN

0 00' 3 75' C1

3 75' 11 00' S1

CASING C1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed

SCREEN S1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed, 0 010" wire wrap screen 0 25' welded bottom cap

CENTRALIZERS Type 304 stainless steel
6 80' - 8 00'FILTER MATERIAL 32-42 silica sand
3 10' - 12 20'CEMENT Portland Type I
0 00' - 2 20'OTHER 3/8" bentonite pellets
2 20' - 3 10'
12 20' - 15 50'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	8/22	1235	8/22	1400
GEOPHYS LOGGING	—	—	—	—
CASING				
2" stainless	8/22	1555	8/22	1556
FILTER PLACEMENT	8/22	1556	8/22	1504
CEMENTING	8/22	1607	8/22	1611
DEVELOPMENT	9/12	1415	9/17	1110
OTHER				
Bentonite	8/22	1604	8/22	1602
	8/22	1550	8/22	1555

WELL DEVELOPMENT

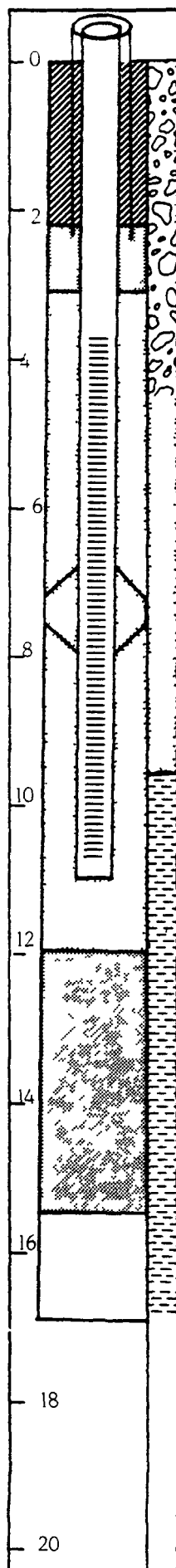
See Well Development Summary Sheet

COMMENTS

Water encountered at 9 46', recorded 1 day after well completed

Top of stainless steel casing 2.01'

Cave from TD to 15 50'

LOCATION Golden, CO
PERSONNEL T MurphyPROJECT 106P06222
Rocky Flats Plant

INDEX OF DATA

Boring No 27-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project: Rocky Flats Plant

LOG OF BORING NO. 27-86

Date Drilled 8/29/86 and 9/12/86 to 9/18/86

Coordinates N 37794 1 E 22134.9

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5961.86

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ARTIFICIAL FILL					
				0-2 0'-Sample Recovered 1 0/2.0'=50% GRAVEL dusky brown (5YR 2/2) granite and quartzite coarse sand, pebbles and cobbles, some fine-grained sand, silty, slightly calcareous, poorly sorted, subangular, unconsolidated, dry					
	5			2 0-4 0'-Sample Recovered 0 9/2 0'=45% GRAVEL Same as above, calcareous, horizontal bedding, poorly sorted, unconsolidated, dry					
				4 0-7 0'-Sample Recovered 3 0/3 0'=100% GRAVEL very pale orange (10YR 6/2) to grayish orange (10YR 7/4) pebbles, grades downward into yellowish orange (10YR 6/6) coarse-grained sand trace silt and clay, noncalcareous, poorly sorted, subangular, damp					
	10			7 0-8.0'-Sample Recovered 0 0/1 0'=0%					
				8 0-12.0'-Sample Recovered 4 0/4 0'=100%					
				8.0-9 2' GRAVEL very pale orange (10YR 6/2) to grayish orange (10YR 7/4) pebbles with dark yellowish orange (10YR 6/6) coarse-grained sand, gravel layer at bottom, poorly sorted; unconsolidated, wet					
	15			ARAPAHOE FORMATION					
				9 2-12 0' CLAYSTONE pale olive (10Y 4/2) to grayish olive (10Y 4/2) with dark yellowish orange (10YR 6/6) mottling, silty, coarse-grained sandstone stringer at 9 8', firm; weathered, damp					
	20								

Remarks Logged by T Murphy & J Bergman

Checked by *[Signature]*

Project No.

106P06222

Hydro-Search, Inc.

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Project. Rocky Flats Plant

LOG OF BORING NO. 27-86

Date Drilled 8/29/86 and 9/12/86 to 9/18/86

Coordinates N 37794.1 E 22134.9

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5961.86

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			12 0'-17 0'-Sample Recovered 5 0/5.0'=100% CLAYSTONE light gray (N 7) to medium gray (N 5) with dark yellowish orange (10YR 6/6) mottling At 15 5' grades into medium dark gray (N 4) claystone, unweathered, damp to wet					
				17 0'-22 0'-Sample Recovered 5 0/5 0'=100%					
	25			17 0'-19 6' CLAYSTONE light gray (N 7) to medium gray (N 5) with dark yellowish orange (10YR 6/6) mottles, firm, damp					
				19 6'-22 0' CLAYSTONE pale olive (10YR 6/2) claystone with slight dark yellowish orange (10YR 6/6) mottling along fractures, some ironstone in fractures; firm, damp					
	30			23 0'-28 5'-Sample Recovered 3 5/5.0'=69% RQD 2 9/3.5'=87% CLAYSTONE dark yellowish orange (10YR 6/6), sandy, grades downward into a dusky yellow (5Y 6/4) sandy claystone; several patches of white very fine-grained sand, consolidated, dry					
	35			28 5'-33 5'-Sample Recovered 2 0/5 0'=40% RQD 1 5/2 0'=75% CLAYSTONE light gray (N 7) and pale yellowish brown (10YR 6/2); white caliche at 31.5' (0.25" thick), strong reaction strongly with HCL, consolidated, dry					
	40			33.5'-38.5'-Sample Recovered 2 1/5.0'=42% RQD 2 1/2 1'=100% CLAYSTONE dark yellowish orange (10YR 6/6) with moderate yellowish brown (10YR 5/4) limonite stains, grades downward into a pale yellowish brown (10YR 6/2) slightly sandy claystone, consolidated; dry.					

Remarks Logged by T Murphy & J Bergman

Checked by Project No.
106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 27-86

Date Drilled 8/29/86 and 9/12/86 to 9/18/86


Coordinates N 37794.1 E 22134.9

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5961.86

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	40			38 5-43.5'-Sample Recovered 3 6/5 0'=73% RQD 3 6/3 6'=100% CLAYSTONE light olive gray (5Y 5/2); some fine to very fine-grained sand, dark yellowish orange (10YR 6/6) mottling, black organic fragments, few caliche stringers, consolidated, dry			
	45			43.5-47 5'-Sample Recovered 1 6/4 0'=40% RQD 0 8/1 6'=50% CLAYSTONE. yellowish brown (10YR 2/2) with some moderate yellowish orange (10YR 6/6) mottling, sandy, few black organic fragments; consolidated, damp			
	50			47.5-52 5'-Sample. Recovered 5.0/5.0'=100% RQD 5 0/5 0'=100% CLAYSTONE olive gray (5Y 3/2), no mottling, homogenous, consolidated, dry			
	55			52 5-57 5'-Sample Recovered 3 5/5 0'=70% RQD 2 5/3.5'=71% CLAYSTONE Same as above; dry			
	60			57 5-62 5'-Sample Recovered 5 0/5 0'=100% RQD 5 0/5 0'=100% CLAYSTONE. olive gray (5Y 3/2) with moderate yellowish brown (10YR 5/4) mottling; at 59 0' and 59 5' hit a thin layer 0 3' and 0.1' thick, respectively, of moderate yellowish brown (10YR 5/4) siltstone nodules; very fine-grained, dry			

Remarks Logged by T Murphy & J Bergman

Checked by Project No.
106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 27-86

Date Drilled 8/29/86 and 9/12/86 to 9/18/86

Coordinates N 37794.1 E 22134.9

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5961.86

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
60				62.5-67 5'-Sample Recovered 5.0/5.0'=100% RQD 5.0/5.0'=100% CLAYSTONE. olive gray (5Y 3/2), sandy, several moderate yellowish brown (10YR 5/4) siltstone nodules at 66.4', 66.9' and 67.0', each layer is less than 0.5' wide; consolidated, moist					
65				67.5-72 5'-Sample Recovered 5.0/5.0'=100% RQD 5.0/5.0'=100% CLAYSTONE. olive gray (5Y 3/2); sandy; moderate yellowish brown (10YR 5/4) siltstone nodules, consolidated, moist.					
70				72.5-77 5'-Sample. Recovered 4.4/5.0'=88% RQD 4.4/4.4'=100% CLAYSTONE. olive gray (5Y 3/2), sandy; layer of moderate yellowish brown (10YR 5/4) siltstone nodules 73.8', consolidated; moist.					
75				77.5-82.5'-Sample. Recovered 4.5/5.0'=90% RQD 4.5/4.5'=100% CLAYSTONE. olive gray (5Y 3/2), sandy; black organic fragments; consolidated, damp					
80									

Remarks Logged by T Murphy & J Bergman

Checked by *[Signature]*

Project No.

106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 27-86

Date Drilled 8/29/86 and 9/12/86 to 9/18/86

Coordinates N 37794.1 E 22134.9

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5961.86

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
80				82 5-87 5'-Sample Recovered 5 0/5 5'=91% RQD 5 0/5 0'=100% CLAYSTONE Same as above, damp					
85				87 5-92 5'-Sample Recovered 5 0/5 0'=100% RQD 5 0/5 0'=100% CLAYSTONE olive gray (5Y 3/2), moderate yellowish brown (10YR 5/4) siltstone nodules 91 8', black organic fragments; consolidated, damp.					
90				92 5-97.5'-Sample Recovered 3 2/5 0'=64% RQD 3.0/3 2'=94% CLAYSTONE olive gray (5Y 3/2); black organic fragments, consolidated, dry					
95				97 5-102.5'-Sample Recovered 5 0/5 0'=100% RQD 2 5/5.0'=50% SILTSTONE olive gray (5Y 3/2), very fine-grained, slightly sandy; black organic fragments; laminated; homogeneous; consolidated, dry.					
100									

Remarks Logged by T Murphy & J Bergman

Checked by *WJP*Project No.
106P06222

Hydro-Search, Inc.

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Project. Rocky Flats Plant

LOG OF BORING NO. 27-86

Date Drilled 8/29/86 and 9/12/86 to 9/18/86

Coordinates N 37794.1 E 22134 9

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5961.86

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	100			102 5-107 5'-Sample Recovered 3 8/5 0'=76% RQD 3 0/3 8=79% SILTSTONE Same as above, dry			
	105			107 5-110 5'-Sample Recovered 3 0/3 0'=100% RQD 3 0/3 0'=100% SILTSTONE Same as above, dry			
	110			110 5-113.5'-Sample Recovered 0.25/3.0'=8% RQD 0 0/0 25'=0% SILTSTONE Same as above, dry			
	115			113.0-117.0'-Sample Recovered 2.2/4.0'=55% RQD 0.1/2 2'=5% CLAYSTONE Olive gray (5Y 3/2), silty, some very fine-grained sand, black organic fragments, homogenous, consolidated, damp			
	120			117.0-122 0'-Sample Recovered 3 5/5.0'=70% RQD 2 7/3 5'=77% CLAYSTONE. olive gray (5Y 3/2), silty; few organics, homogenous; damp			

Remarks Logged by T Murphy & J Bergman

Checked by *JP*

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Project: Rocky Flats Plant

LOG OF BORING NO. 27-86

Date Drilled 8/29/86 and 9/12/86 to 9/18/86

Coordinates N 37794.1 E 22134.9

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5961.86

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	120			122 0-127 0'-Sample Recovered 5 0/5 0'=100% RQD 5 0/5 0'=100% CLAYSTONE olive gray (5Y 3/2), silty, some very fine-grained sand, few organic fragments, homogenous, hard, dry					
				127 0-132 0'-Sample Recovered 5 0/5 0'=100% RQD 5 0/5 0'= 100%					
	125			127 0-129 0' CLAYSTONE olive gray (5Y 3/2), sandy, black organic fragments, homogeneous, consolidated, dry					
				129.0-132 0' SANDSTONE clay grades into light gray (N7) sandstone, silty, very fine-grained, thin clay laminae, few organics, well sorted, rounded, consolidated, dry					
	130			132.0-137 0'-Sample Recovered 3 5/5 0'=70% RQD 2 3/3.5=66% 132 0-133 9' SANDSTONE light gray (N7), silty, very fine-grained, very thin clay laminae, well sorted, rounded, consolidated, dry					
	135			133.9-137 0. CLAYSTONE grades into olive gray (5Y 3/2) claystone; silty and sandy, laminations in sandy intervals; no organics, consolidated, dry.					
				137.0-142.0'-Sample Recovered 3 2/5 0'=64% RQD 2.2/3 2'=69% CLAYSTONE olive gray (5Y 3/2), light brown (5YR 6/4) mottling; no organics, homogenous; slightly damp					
	140								

Remarks Logged by T Murphy & J Bergman

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Project. Rocky Flats Plant

LOG OF BORING NO. 27-86

Date Drilled 8/29/86 and 9/12/86 to 9/18/86

Coordinates N 37794.1 E 22134.9

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5961.86

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	140								
				142.0-147 0'-Sample Recovered 5 0/5 0'=100% RQD 3 8/5 0'=76% CLAYSTONE olive gray (5Y 3/2); silty; some very fine-grained sand; grades downward into very fine-grained gray (N 7) sandstone, silty, few organics, laminated, well sorted, rounded, consolidated, dry					
	145								
				147 0-152 0'-Sample Recovered 5 0/5 0'=100% RQD 5 0/5 0'=100% CLAYSTONE olive gray (5Y 3/2) silty claystone and pale olive (10Y 6/2) very fine-grained silty sandstone, sandstone layers are less than 0 1' thick, well sorted, few organics; 2 dusky yellow (5Y 6/4) siltstone pockets at 148 0'; sample exhibits increased clay content with depth, consolidated; hard, slightly damp					
	150								
	155								
				152.0-157.0'-Sample Recovered 3 1/5.0'=62% RQD 0 8/3.1'=26% CLAYSTONE alternating bands of olive gray (5Y 3/2) claystone and very fine-grained gray (N 7) silty sandstone; grades downward into olive gray (5Y 3/2) silty claystone, pale yellowish brown (10YR 6/2) siltstone nodule at 155 0'; consolidated; slightly damp					
				TOTAL DEPTH: 157.0'					
	160								

Remarks Logged by T Murphy & J Bergman

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Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS _____
 N 37794 1 E 22134 9

ELEVATION GROUND LEVEL 5961 86'
 TOP OF CASING 5963 26'

DRILLING SUMMARY

TOTAL DEPTH Well 133 00' Hole 157 00'
 BOREHOLE DIAMETER 0 00' - 22 00' 7 1/2"
 22 00' - 157 00' 5 5/8"
 DRILLER Boyles Brothers Drilling Co
 15865 W 5th Avenue, Golden, CO
 (Dave Jarvie, Robert Roach)
 0 00' - 22 00' Mobile B-57, 22 00' -
 RIG 157 00' Failing
 BIT(S) 0 00' - 22 00' T5, 22 00' - 157 00'
 coring bit, stone bit, tricone
 DRILLING FLUID 0 00' - 22 00' none, 22 00' -
 157 00' air/water mist
 SURFACE CASING 5" x 22 6' steel w/ locking
 cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG _____
 CASING STRING(S) C=CASING S=SCREEN
 0 00' 21 00' C1 _____
 0 00' 128 50' C2 _____
 128 50' 133 00' S1 _____

 CASING C1 5" I.D. steel surface casing
 C2 2" I D Sch 5 type 316 stain-
 less steel, threaded and flush
 jointed
 SCREEN S1 2" I.D. Sch. 5 type 316 stain-
 less steel, threaded and flush
 jointed, 0 010" wire wrap screen,
 0 25' welded bottom cap
 CENTRALIZERS None

FILTER MATERIAL 32-42 silica sand
 127 50' - 135 70'

CEMENT Portland Type I
 0 00' - 126 50'

OTHER 3/8" bentonite pellets
 126 50' - 127 00'
 135 75' - 157 00'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	8/29	0935	8/29	1200
NC core	9/11	1545	9/17	1615
Reaming	9/19	0905	9/19	0945
GEOPHYS LOGGING	—	—	—	—
CASING				
5" steel	8/29	1300	8/29	1330
2" stainless	9/22	1110	9/22	1135
FILTER PLACEMENT	9/22	1140	9/22	1150
CEMENTING	9/23	1820	9/24	0920
DEVELOPMENT	9/30	1215	10/1	0912
OTHER				
Bentonite	9/22	1520	9/22	1620
	9/19	1625	9/19	1700
Packer testing				
Cementing 5" steel	8/29	1330	8/29	1400

WELL DEVELOPMENT

See Well Development Summary Sheet

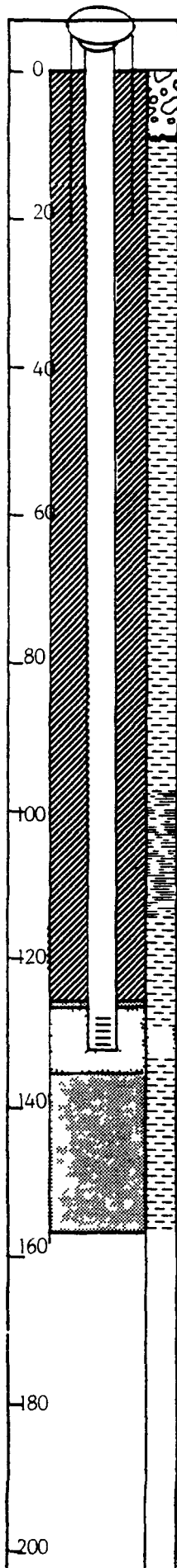
COMMENTS

Water encountered at 8 0' during drilling

Top of stainless steel casing 1 40'

LOCATION Golden, CO
 PERSONNEL T. Murphy/J. Bergman

PROJECT 106P06222
 Rocky Flats Plant



INDEX OF DATA

Boring No 28-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project. Rocky Flats Plant


LOG OF BORING NO. 28-86

Date Drilled 8/28/86


Coordinates N 37816.2 E 22137.1

Boring Method Hollow Stem Auger

Ground Surface Elevation 5961.23

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			<p>ARTIFICIAL FILL</p> <p>0-1 0'-Sample Recovered 0 8/1.0'=80% GRAVEL grayish orange pink (5YR 7/2) to very pale orange (10YR 8/2) granite, quartzite and sandstone pebbles, sandy, silty, calcareous, poorly sorted, subangular to subrounded; unconsolidated, dry</p> <p>1 0-2 0'-Sample Recovered 0 0/1 0'=0%</p> <p>2 0-4 0'-Sample Recovered 1 5/2.0'=75% GRAVEL Same as above, trace silt and very light gray (N 8) sand, grayish orange (10YR 7/4) gravel layer from 3 5-4 0', calcareous, poorly sorted, unconsolidated, dry</p> <p>4 0-5.5'-Sample Recovered 1.5/1.5'=100% GRAVEL Same as above, trace silt and very light gray (N 8) sand, white (N 9) fine silt layer at 4 9'; calcareous; dusky yellow green (5GY 5/2) fine-grained sand and silt layer from 5.4-5 5', moderately sorted, unconsolidated, dry</p> <p>5.5-8.0'-Sample Recovered 0.0/2.5'=0%</p>					
	2								
	4								
	6								
	8								

Remarks Logged by T Murphy

Checked by 

Project No.
106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 28-86

Date Drilled 8/28/86

Coordinates N 37816.2 E 22137.1

Boring Method Hollow Stem Auger

Ground Surface Elevation 5961.23

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	8			8 0-12.5'-Sample Recovered 4 5/4 5'=100%					
				8 0-8.4' GRAVEL Same as above; trace silt and very light gray (N 8) sand, poorly sorted, subangular to subrounded, unconsolidated, dry					
				ARAPAHOE FORMATION					
	10			8 4-12 5' CLAYSTONE pale olive (10YR 6/2) with dark yellowish orange (10YR 6/6) mottling, trace silt, thin coarse sand lense at 9 1-9 2', slightly calcareous, weathered, damp					
	12								
				12.5-15 5'-Sample Recovered 3 0/3.0'=100%					
				CLAYSTONE pale olive (10YR 6/2) with dark yellowish orange (10YR 6/6) mottles, trace silt, weathered, grades downward into brownish gray (5YR 4/1) claystone, damp					
	14								
	16			TOTAL DEPTH 15.5'					

Remarks Logged by T Murphy

Checked by *[Signature]*

Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS

N 37816 2 E 22137.1

ELEVATION GROUND LEVEL

5961 23'

TOP OF CASING

5963 77'

DRILLING SUMMARY

TOTAL DEPTH Well 8 60' Hole 15 50'

BOREHOLE DIAMETER 7 1/4"

DRILLER Boyles Brothers Drilling Co

15865 W 5th Avenue

Golden, CO (Dave Jarvie)

RIG Mobile B-57

BIT(S) T5

DRILLING FLUID None

SURFACE CASING 5" x 5' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG ☒ GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

0 00'

4 03'

8 60'

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CASING C1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed

SCREEN S1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed, 0 010" wire wrap screen 0 25' welded bottom cap.

CENTRALIZERS Type 304 stainless steel 6 75' - 5 55'

FILTER MATERIAL 32-42 silica sand 2 70' - 9 70'

CEMENT Portland Type I 0 00' - 2 00'

OTHER 3/8" bentonite pellets 2 00' - 2 70' 9 70' - 15 10'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/4" auger	8/29	1007	8/29	1230
GEOPHYS LOGGING	—	—	—	—
CASING				
2" stainless	8/29	1532	8/29	1532
FILTER PLACEMENT	8/29	1530	8/29	1615
CEMENTING	8/29	1630	8/29	1632
DEVELOPMENT	9/12	1325	9/18	1300
OTHER				
Bentonite	8/29	1615	8/29	1630
	8/29	1515	8/29	1530

WELL DEVELOPMENT

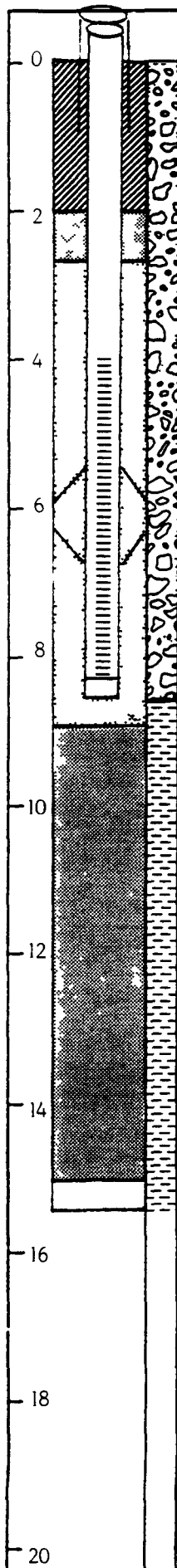
See Well Development Summary Sheet

COMMENTS

No water encountered during drilling

Top of stainless steel casing 2 54'

Cave from TD to 15.10'

LOCATION Golden, CO
PERSONNEL I MurphyPROJECT 106P06222
Rocky Flats Plant

INDEX OF DATA

Boring No 29-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project. Rocky Flats Plant

LOG OF BORING NO. 29-86

Date Drilled 9/9/86

Coordinates N 37610.3 E 22584.1

Boring Method Hollow Stem Auger

Ground Surface Elevation 5958.26

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ROCKY FLATS ALLUVIUM					
				0 0-2 0'-Sample Recovered 0 5/2 0'=25% GRAVEL grayish brown (5YR 3/2) to dusky brown (5YR 2/2) granite and quartzite pebbles and cobbles, sand and silt matrix, bimodal sorting, subangular, unconsolidated, loose, damp					
	5			2 0-3 6'-Sample Recovered 1 6/1 6'=100% GRAVEL moderate brown (5YR 4/4) granite and quartzite pebbles and cobbles, sandy, some silt, poorly sorted, subangular, well packed, damp					
				3.6-6.5'-Sample. Recovered 0.0/3 0'=0% Cuttings. GRAVEL light brown (5YR 5/6) granite and quartzite pebbles and cobbles, unconsolidated, dry					
	10			6.5-7 5'-Sample GRAVEL light brown (5YR 6/4) granitic pebbles and cobbles; medium to coarse sand, poorly sorted, angular; unconsolidated, dry to damp					
				7 5-12.5'-Sample Recovered 4 3/5 0'=86%					
	15			7 5-8 7'. CLAY olive gray (5Y 3/2) and grayish brown (9YR 2/2), gravelly, some sand and silt, caliche stringers; soft, moist					
				ARAPAHOE FORMATION					
				8 7-12.5' CLAYSTONE yellowish gray (5Y 7/2) to dusky yellow (5Y 6/4), silty, weathered, firm, moist					
	20								

Remarks Logged by T Murphy

Checked by 

Project No.

106P06222

Hydro-Search, Inc.

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Project Rocky Flats Plant

LOG OF BORING NO. 29-86

Date Drilled 9/9/86

Coordinates N 37610.3 E 22584.1

Boring Method Hollow Stem Auger

Ground Surface Elevation 5958.26

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	20			12 5-17 5'-Sample. Recovered 5 0/5.0'=100% CLAYSTONE pale olive (10Y 6/2) with dark yellowish orange (10YR 6/6) mottling, fine-grained to coarse-grained sand stringers, occasional calcite in fractures (dark yellowish orange 10YR 6/6), 50% sand and 50% claystone, firm, moist			
	25			17 5-22.5'-Sample Recovered 2 0/5 0'=40% SANDSTONE dark yellowish orange (10YR 6/6) and light gray (N 7), silty, some clay, moist, soft			
				22 5-25 5' Lost core			
				TOTAL DEPTH 25.5'			
	30						
	35						
	40						

Remarks Logged by T Murphy

Checked by Project No.
106P06222

Hydro-Search, Inc.

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INDEX OF DATA

Boring No 30-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project: Rocky Flats Plant

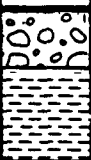
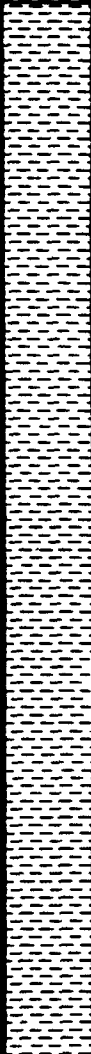
LOG OF BORING NO. 30-86

Date Drilled 9/6/86

Coordinates N 38092.5 E 21819.6

Boring Method Hollow Stem Auger

Ground Surface Elevation 5956.21

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			<p>ARTIFICIAL FILL</p> <p>0 0-2 0'-Sample Recovered 1 2/2 0'=60% 0.0-0 8' GRAVEL granite and quartzite pebbles, sandy, silty, poorly sorted, wet</p> <p>0 8-2 0' CLAYSTONE dusky brown (5Y 2/2) and olive gray (5Y 3/2), silty, moist to wet</p>					
	5			<p>ARAPAHOE FORMATION</p> <p>2 0-4 0'-Sample Recovered 2.0/2 0'=100% CLAYSTONE light olive gray (5Y 5/2), some dark yellowish orange (10YR 6/6) iron staining, slightly calcareous, silty, firm, moist</p> <p>4.0-6 0'-Sample. Recovered 2 0/2.0'=100% CLAYSTONE. light olive gray (5Y 5/2), some dark yellowish orange (10YR 6/6) iron staining; fragments of calcite, some light olive gray (5Y 5/2) fine-grained sand, soft to moderately firm, moist</p> <p>6.0-11 0'-Sample Recovered 5.0/5 0'=100% CLAYSTONE light olive gray (5Y 5/2), some dark yellowish orange (10YR 6/6) iron stains; calcite concretion at 6.3'; firm, damp.</p> <p>11.0-16.0'-Sample. Recovered 5.0/5.0'=100% CLAYSTONE olive gray (5Y 3/2) to olive brown (5Y 4/4); firm, damp.</p> <p>TOTAL DEPTH: 16 0'</p>					
	20								

Remarks Logged by T Murphy

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WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS _____
 N 38092 5 E 21819 6

 ELEVATION GROUND LEVEL 5956 21'
 TOP OF CASING 5957 62'

DRILLING SUMMARY

 TOTAL DEPTH Well 14 93' Hole 16 00'
 BOREHOLE DIAMETER 7 1/4"
 DRILLER Bovles Brothers Drilling Co
 15865 W 5th Avenue
 Golden, CO (Dave Jarvie)
 RIG Mobile B-57
 BIT(S) Blade bit
 DRILLING FLUID None
 SURFACE CASING 5" x 4" steel w/ locking cap

WELL DESIGN

 BASIS GEOLOGIC LOG ☒ GEOPHYSICAL LOG _____
 CASING STRING(S) C=CASING S=SCREEN

0 00'	2 48'	C1	-	-
2 48'	14 93'	S1	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

 CASING C1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed
 SCREEN S1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed, 0 010" wire wrap screen
 0 25' welded bottom cap
 CENTRALIZERS Type 304 stainless steel
 FILTER MATERIAL 32-42 silica sand
 2.20' - 15 10'
 CEMENT Portland Type I
 0 00' - 2 00'
 OTHER 3/8" bentonite pellets
 2 00' - 2 20'
 15 10' - 15 60'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/4" auger	9/6	1200	9/6	1430
GEOPHYS LOGGING	-	-	-	-
CASING				
2" stainless	9/6	1630	9/6	1635
FILTER PLACEMENT	9/6	1635	9/6	1650
CEMENTING	9/6	1650	9/6	1700
DEVELOPMENT	9/12	1010	9/19	1030
OTHER				
Bentonite	9/6	1641	9/6	1642
	9/6	1625	9/6	1630

WELL DEVELOPMENT

See Well Development Summary Sheet

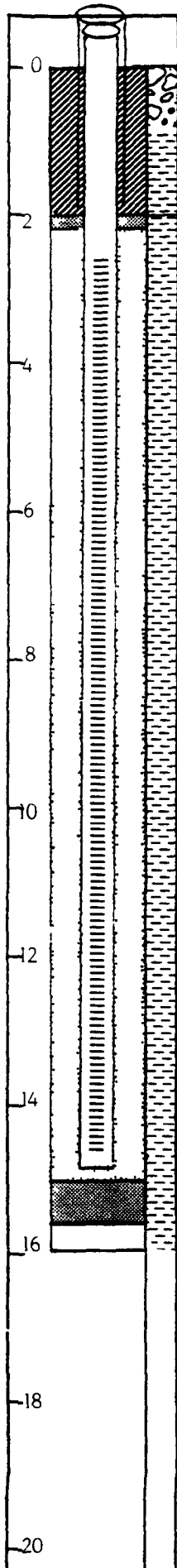
COMMENTS

No water encountered during drilling

Top of stainless steel casing 1.41'

Cave from TD to 15.60'

 LOCATION Golden, CO
 PERSONNEL T. Murphy

 PROJECT 106P06222
 Rocky Flats Plant


INDEX OF DATA

Boring No 31-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project Rocky Flats Plant

LOG OF BORING NO.


31-86

Date Drilled 9/2/86

Coordinates N38066 2 E 21661 8

Boring Method Hollow Stem Auger

Ground Surface Elevation 5964.21'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			<p>ARTIFICIAL FILL</p> <p>0-2.0'-Sample Recovered 2 0/2.0'=100%.</p> <p>0-0.9' SILTY GRAVEL. grayish brown (5YR 2/2) very fine-grained sand, silt and gravel, few roots; poorly sorted; angular; unconsolidated; dry.</p> <p>ARAPAHOE FORMATION</p> <p>0.9-2.0' SAND: light gray (N 8/0) to dusky brown (5YR 3/2) medium to fine- grained; some clayey sand, moderately sorted; firm; apparent bedding from variation in clay fraction; alternating layers of sand and clayey sand; dark yellow stain (10YR 6/6) increase in sand and silt percent from 1.5-2.0'; firm; damp.</p> <p>2.0-4.0'-Sample Recovered 1.2/2 0'=60%.</p> <p>SAND: light gray (N 8/0) to grayish orange (10YR 4/4); medium-grained sand, some clay and silt; dark yellowish orange (10YR 6/6) mottles; calcareous sand from 3.0-3.5'; firm; damp.</p> <p>4.0-7.0'-Sample. Recovered 3.0/3.0'=100%.</p> <p>SAND: grayish orange (10YR 7/4); silty and clayey sand at 4.9 and 6.2'; calcareous fracture at 6.8'; medium to fine- grained; quartz predominates; soft; damp.</p>					
	5								
	10								
	15								
	20								

Remarks

Logged by T Murphy

Checked by 

Project No

106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO.

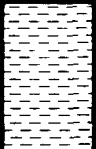
31-86

Date Drilled 9/2/86


Coordinates N 38066 2 E 21661.8

Boring Method Hollow Stem Auger

Ground Surface Elevation 5064.21'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20								
	25			7.0-12.0'-Sample. Recovered 5.0/5.0'=100%. SAND. grayish orange (10YR 7/4), medium to fine- grained, moderately clean, some silt, slight color variation to pale olive (10YR 6/2) with depth, soft; damp					
				12.0-17.0'-Sample. Recovered 4.0/5.0'=80%. 12.0-14.9' SAND pale olive (10YR 6/2) to grayish orange (10YR 7/4); medium to fine-grained; moderately clean; some silt; soft; damp.					
	30			14.9-16.5' CLAYSTONE: grayish olive (10Y 9/2); dark yellowish orange (10YR 6/6) mottles; occasional thin sand layers at 14.8 and 15.8'; slightly calcareous, firm; damp.					
				16.5-17.0': CLAYSTONE: dark olive gray (5Y 3/2); silty; black wood fragments; firm; damp.					
	35			17.0-22.0'-Sample. Recovered 5.0/5.0'=100%. 17.2-17.7' CLAYSTONE: dark olive gray (5Y 3/2); silty; black wood fragments; firm; damp.					
				17.7-20.0': SAND: pale olive (10Y 6/2); yellowish orange (10YR 6/6) mottles; some fine-grained sand; occasional sand lenses 0.2' thick; silty; firm; damp.					
	40								

Remarks Logged by T. Murphy

Checked by: 

Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS _____
 N 38066.2 E 21661.8

ELEVATION GROUND LEVEL 5964 21'
 TOP OF CASING 5966 67'

DRILLING SUMMARY

TOTAL DEPTH Well 17 32' Hole 22 00'
 BOREHOLE DIAMETER 7 1/2"

DRILLER Boyles Brothers Drilling Co
 15865 W 5th Avenue, Golden, CO

Dave Jarvie

RIG Mobile B-57

BIT(S) T-5

DRILLING FLUID None

SURFACE CASING 5' x 5' steel w/ locking cap

WELL DESIGN.

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG _____

CASING STRING(S) C=CASING S=SCREEN

0 00'	2 46'	C1		
2 46'	17 32'	S1		

CASING C1 2" I D, Sch 5 Type 316 stainless steel, threaded and flush jointed

SCREEN S1 2" I D, Sch 5 Type 316 stainless steel, threaded and flush jointed, 0 010" wire wrap screen, 0 25' welded bottom cap

CENTRALIZERS Type 304 stainless steel
 4 00' - 5 00', 9 00' - 10 80'

FILTER MATERIAL 32-42 silica sand
 2 40' - 18.30'

CEMENT Portland Type I
 0 00' - 1 80'

OTHER 3/8" bentonite pellets
 1 80' - 2 40'
 18 30' - 22 00'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	9/2	1100	9/2	1255
GEOPHYS LOGGING	—	—	—	—
CASING				
2" stainless	9/2	1445	9/2	1450
FILTER PLACEMENT	9/2	1503	9/2	1510
CEMENTING	9/2	1515	9/2	1530
DEVELOPMENT	9/12	1240	9/12	1240
OTHER				
Bentonite	9/2	1510	9/2	1515
	9/2	1430	9/2	1445

WELL DEVELOPMENT

See Well Development Summary Sheet

COMMENTS:

No water encountered during drilling

Top of stainless steel casing 2 46'

INDEX OF DATA

Boring No 32-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

Project. Rocky Flats Plant

LOG OF BORING NO. 32-86

Date Drilled 9/3/86, 9/22/86-9/25/86

Coordinates N 38065 7 E 21640 7

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 3964 46'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ARTIFICIAL FILL					
				0-2.0'-Sample. Recovered 2.0/2.0'=100%.					
				0-0.8' TOP SOIL dark yellowish brown (10YR 4/2); unconsolidated, dry.					
				ARAPAHOE FORMATION					
	5			0 8-2 0' SANDSTONE: light gray (N 7), medium to fine- grained; mostly fine- grained sand and silt, slightly calcareous, massive; no apparent bedding; well sorted; firm, dry.					
				2.0-4.0'-Sample. Recovered 2.0/2.0'=100%.					
	10			SANDSTONE: light gray (N 7); dark yellowish orange (10YR 6/6) stains; increase in silt content; soft; well sorted; dry.					
				4.0-7.0'-Sample. Recovered 3.0/3.0'=100%					
				SANDSTONE: light gray (N 7) with dark yellowish orange (10YR 6/6) mottling; increased clay and silt at 4.8' to 6.3'; bedding 0.05' thick, apparent bedding from variations in staining; leaf imprints; very slightly calcareous along fractures; soft; damp.					
	15			7.0-12.0'-Sample. Recovered 5.0/5.0'=100%.					
				SANDSTONE: medium light gray (N 6) to medium dark gray (N 4); fine to very fine-grained; silty with some clay, dark yellowish orange (10YR 6/6) stains, clayey sand layers alternate with sand layers 0.5-0.8' thick; soft; damp.					
	20								

Remarks

Logged by T Murphy & J Bergman

Checked by *[Signature]*

Project No.

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Hydro-Search, Inc.

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Project Rocky Flats Plant

LOG OF BORING NO. 32-86

Date Drilled 9/3/86, 9/22/86-9/25/86

Coordinates N 38065.7 E 21640 7

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5964.46'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			12.0-17.0'-Sample. Recovered 5.0/5.0'=100% 12.0-16.5' SANDSTONE: medium light gray (N 6) to medium dark gray (N 4); fine to very fine-grained; silty with some clay, dark yellowish orange (10YR 6/6) stains; soft; damp. 16.5-17.0' CLAYSTONE: medium gray (N 5) to dark gray (N 2) and pale olive (10YR 6/2), black wood fragments; amount of clay and thickness of beds increase with depth, firm, damp.					
	25			17.0-22.0'-Sample. Recovered 5.0/5.0'=100%. CLAYSTONE: grayish olive (10Y 4/2) to medium gray (N 5); dark yellowish orange (10YR 6/6) mottles; calcareous thin sand lenses at 18.0 and 18.5'; lenses are 0.01-0.02' thick; firm; damp.					
	30			22.0-27.0'-Sample. Recovered 5.0/5.0'=100%. CLAYSTONE: grayish olive (10Y 4/2) to medium gray (N 5); dark yellowish orange (10YR 6/6) mottles, firm; damp.					
	35			25.0-31.0'-Sample. Recovered 0.0/6.0'=0%. 31.0-36.0'-Sample. Recovered 2.8/5.0'=56%. RQD=1.7/2.8'=12%. CLAYSTONE: pale yellowish brown (10YR 6/2) clay and silty clay; abundant moderate yellowish brown (10YR 5/4) mottles; very well sorted; few organics; consolidated; damp.					
	40			36.0-41.5'-Sample. Recovered 0.0/5.5'=0%.					

Remarks Logged by T Murphy & J Bergman

Checked by *JJP*

Project No.

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Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 32-86

Date Drilled 9/3/86, 9/22/86 - 9/25/86

Coordinates N 38065 7 E 21640 7

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5964.46'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	40			41.5-47.0'-Sample Recovered 2.0/5.5'=36% RQD=0.3/2.0'=17%. CLAYSTONE olive gray (5Y 3/2); abundant dark yellowish orange (10YR 6/6) limonite stains predominantly along vertical fractures, consolidated, very well sorted; moist.					
	45			47.0-52.0'-Sample Recovered 3.7/5.0'=74%. RQD=2.0/3.7'=54%. CLAYSTONE. light olive gray (5Y 5/2); abundant dark yellowish orange (10YR 6/6) and dusky red (5R 3/2) iron staining along fractures; some organics, very well sorted; consolidated; moist.					
	50			52.0-57.0'-Sample. Recovered 4.0/5.0'=80%. RQD=3.5/4.0'=88%. CLAYSTONE olive gray (5Y 3/2); abundant dark yellowish orange (10YR 6/6) stains; few dusky red (5R 3/2) stains, few organics; very well sorted; consolidated; slightly damp.					
	55			57.0-62.0'-Sample. Recovered 4.3/5.0'=86%. RQD= 3.2/4.3'=75%. CLAYSTONE. olive gray (5Y 3/2); some black organic fragments; few wood fragments; some moderate yellowish brown siltstone, very well sorted, consolidated; firm; damp.					
	60								

Remarks Logged by T Murphy & J. Bergman

Checked by *JMP*Project No.
106P06222

Hydro-Search, Inc.

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Project Rocky Flats Plant

LOG OF BORING NO. 32-86

Date Drilled 9/3/86, 9/22/86 - 9/25/86


Coordinates N 38065.7 E 21640 7

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5964 46'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	60			62.0-67 0'-Sample. Recovered 5.0/5.0'=100%. RQD=4.0/5.0'=80% CLAYSTONE. olive gray (5Y 3/2); few yellowish orange mottles (10YR 5/4); no organics; very well sorted; consolidated; damp					
	65			67.0-72.0'-Sample. Recovered 0.6/5.0'=12%. RQD=0.0/0.6'=0%. CLAYSTONE olive gray (5Y 3/2); few moderate yellowish brown (10YR 5/4) mottles; well sorted; consolidated; no organics; homogenous, damp					
	70			72.0-77.0'-Sample. Recovered 2.5/5 0'=50%. RQD=0.6/2.5'=24% CLAYSTONE olive gray (5Y 3/2); very well sorted; consolidated; homogenous; several black organic fragments; slightly damp.					
	75			78.0-83.0'-Sample. Recovered 3.0/5.0'=60%. RQD=2.2/3.0'=73%. CLAYSTONE: olive gray (5Y 3/2); moderate yellowish brown (10YR 5/4) siltstone nodules; well sorted; consolidated; homogenous; no organics; moist.					
	80								

Remarks Logged by T Murphy & J Bergman

Checked by Project No.
106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 32-86

Date Drilled 9/3/86, 9/22/86 - 9/25/86

Coordinates N 38065 7 E 21640 7

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5964.26'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	80			83.0-87.0'-Sample. Recovered 3.0/4.0'=75% RQD=1.4/3.0'=47%. CLAYSTONE olive gray (5Y 3/2), common moderate yellowish brown (10YR 5/4) mottles and siltstone nodules; well sorted; consolidated; homogenous; moist.					
	85			87.0-92.0'-Sample Recovered 3.8/5.0'=76%. RQD=0.0/3.8'=0%. CLAYSTONE. olive gray (5Y 3/2); interbedded gray (N 7) sandy and silty clay; very fine-grained; well sorted; consolidated; nicely laminated 0.7'thick; moist.					
	90			92.0-97.0'-Sample. Recovered. 2/5.0'=64%. RQD=2.9/3.2'=91%. SILTY SANDSTONE: light gray (N 7) interbedded with olive gray (5Y 3/2) silty clay; very fine-grained; very well sorted; rounded; consolidated; dry.					
	95			97.0-103.0'-Sample. Recovered 3.6/6.0'=60%. RQD=1.3/3.6'=36%. CLAYSTONE: olive gray (5Y 3/2) clay and silty clay; very fine-grained; little sand; few moderate yellowish brown mottles (10YR 5/4); very well sorted; consolidated; slightly damp.					
	100								

Remarks Logged by T Murphy & J Bergman

Checked by *[Signature]*

Project No.
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Hydro-Search, Inc.

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Project Rocky Flats Plant

LOG OF BORING NO. 32-86

Date Drilled 9/3/86, 9/22/86 - 9/25/86

Coordinates N 38065 7 E 21640 7

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5964.46'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	100			103.0-107.0'-Sample Recovered 2.3/4.0'=58%. RQD=0.0/2.3'=0%. CLAYSTONE olive gray (5Y 3/2) clay and silty clay, some very fine-grained sand; very well sorted, rounded; slightly damp					
	105			107.0-112.0'-Sample Recovered 2.3/5.0'=46%. RQD=1.1/2.3'=48%. CLAYSTONE olive gray (5Y 3/2) clay and silty clay, very well sorted, consolidated; slightly damp.					
	110			112.0-117.0'-Sample. Recovered 4.2/5.0'=83%. RQD=2.8/4.2'=67%. 112.8- 115.2': CLAYSTONE. olive gray (5Y 3/2) clay and silty clay; abundant yellowish brown (10YR 5/4) pebble and gravel-sized nodules; angular; moderately sorted; dry 115.2-117'. SAND. light gray (N 7/0), very fine- grained; gradational contact; very well sorted; rounded; consolidated; dry					
	115			117.0-122.0'-Sample. Recovered 2.2/5.0'=44%. RQD=0.5/2.2'=23%. SAND: light gray (N 7/0); very fine-grained and silty sand; very well sorted, rounded; consolidated; lower 1.0' becomes laminated with alternating layers of olive gray (5Y 3/2) clay and gray (N 7) very fine-grained sand; dry					
	120								

Remarks Logged by T Murphy & J Bergman

Checked by *[Signature]*Project No.
106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 32-86

Date Drilled 9/3/86, 9/22/86 - 9/25/86

Coordinates N 38065.7 E 21640.7

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5964.46'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	120			122.0-127.0'-Sample. Recovered 4.2/5.0'=84%. RQD=4.0/4.2'=95%. SILTY SAND: light gray (N 7/0); fine and very fine-grained sand and silty sand; thinly laminated with alternating layers of olive gray (5Y 3/2) clay and light gray (N 7) sand; well sorted; consolidated; rounded; dry.					
	125			127.0-132.0'-Sample Recovered 2.0/5.0'=40% RQD=0.8/2.0'=40% CLAYSTONE: olive gray (5Y 3/2) clay and silty clay, one moderate yellowish brown (10YR 5/4) siltstone layer at 131.0' 0.02' wide; very well sorted; consolidated; rounded; dry					
	130			132.0-135.0'-Sample. Recovered 1.5/3.0'=50%. RQD=0.0/3.0'=0% CLAYSTONE: olive gray (5Y 3/2); no mottles; well sorted; consolidated; homogenous; dry.					
	135			TOTAL DEPTH: 135.0'					
	140								

Remarks Logged by T Murphy & J Bergman

Checked by *[Signature]*

Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS _____
 N 38065 7 E 21640 7

 ELEVATION GROUND LEVEL 5964 46'
 TOP OF CASING 5966 96'

DRILLING SUMMARY

 TOTAL DEPTH Well 125 50' Hole 135.00'
 BOREHOLE DIAMETER 0 00' - 27 00' 7 1/2"
 27 00' - 135 00' 5 5/8"
 DRILLER Boyles Brothers Drilling Co
 15865 W 5th Avenue, Golden, CO
 (Dave Jarvie, Robert Roach)
 RIG 0 00'-27 00' Mobile B-57, 27 00'-135 00'
 BIT(S) 0 00' - 27 00' T-5
 27 00' - 135 00' Carbide bit
 DRILLING FLUID 0 00' - 27 00' None
 27 00' - 135 00' air/water must
 SURFACE CASING 5" x 30 50' steel w/ lock-
 ing cap

WELL DESIGN

 BASIS GEOLOGIC LOG ☒ GEOPHYSICAL LOG _____
 CASING STRING(S) C=CASING S=SCREEN
 0 00' 27 00' C1 - - -
 0 00' 114 90' C2 - - -
 114 90' 125.50' S1 - - -
 - - - - -
 - - - - -
 - - - - -
 - - - - -
 - - - - -
 - - - - -

 CASING C1 5" I D steel surface casing
 C2 2" I D Sch 5 type 316 stain-
 less steel, threaded and flush
 jointed
 SCREEN S1 2" I D Sch 5 type 316 stain-
 less steel, threaded and flush
 jointed, 0 010" wire wrap screen,
 0 25' welded bottom cap

CENTRALIZERS None

 FILTER MATERIAL 32-42 silica sand
 112 00' - 114.00'

 CEMENT Portland Type I
 0 00' - 112.00'

 OTHER 3/8" bentonite pellets
 112 00' - 114 00'
 126 00' - 135 00'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	9/3	1030	9/3	1210
NC core	9/23	1600	9/25	1515
Reaming	9/27	1000	9/27	1200
GEOPHYS LOGGING	-	-	-	-
CASING				
5" steel	9/3	1445	9/3	1505
2" stainless	9/29	0920	9/29	0950
FILTER PLACEMENT	9/29	1055	9/29	1415
CEMENTING	9/29	1530	9/29	1630
DEVELOPMENT	10/14	1430	11/7	0945
OTHER				
Bentonite	9/29	1415	9/29	1445
	9/27	1305	9/27	1310
Packer testing	9/25	1330	9/27	0940
Cementing 5" steel	9/3	1506	9/3	1530

WELL DEVELOPMENT

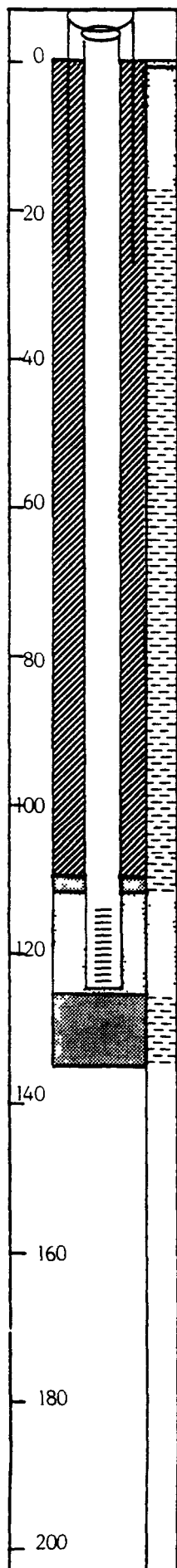
See Well Development Summary Sheet

COMMENTS

No water encountered during drilling

Top of stainless steel casing 2 50'

 LOCATION Golden, CO
 PERSONNEL J. Murphy/J. Bergman

 PROJECT 106P06222
 Rocky Flats Plant


INDEX OF DATA

Boring No 33-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project Rocky Flats Plant

LOG OF BORING NO. 33-86

Date Drilled 9/10/86

Coordinates N 36960.9 E 21896.5

Boring Method Hollow Stem Auger

Ground Surface Elevation 5949 28'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ROCKY FLATS ALLUVIUM					
				0-4.8'-Sample. Recovered 3.1/4.8' = 65%. GRAVEL: light olive gray (5Y 5/2) to olive gray (5Y 3/2); clayey silt and sand matrix; quartzite pebbles; poorly sorted; subangular; crumbles; dry.					
	5			4.8-6.8'-Sample. Recovered 2.0/2.0' = 100%. GRAVEL: light olive gray (5Y 5/2); clayey sand matrix; quartzite cobbles and gravel clasts; angular to subangular; moderate sorting; loose; dry.					
	10			ARAPAHOE FORMATION					
				6.8-11.8'-Sample. Recovered 5.0/5.0' = 100%. 6.8-7.0': GRAVEL: light olive gray (5Y 5/2); clayey sand matrix; quartzite cobbles and gravel clasts; angular to subangular; moderate sorting; loose; dry.					
	15			7.0-11.8': CLAYSTONE: grayish yellow green (5GY 7/2) to grayish olive green (5GY 3/2) with olive gray (5Y 3/2) to greenish gray (5GY 6/1) and dark yellowish orange (10YR 6/6) stains; well sorted; consolidated; fractured; firm; damp.					
	20								

Remarks Logged by T Murphy

Checked by Project No.
106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 33-86

Date Drilled 9/10/86

Coordinates N 36960 9 E 21896.5

Boring Method Hollow Stem Auger

Ground Surface Elevation 5949.28'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20								
	25								
	30								
	35			11.8-16.8'-Sample. Recovered 5.0/5.0'=100%. RQD 5.0/5.0'=100%. CLAYSTONE: grayish yellow green (5GY 7/2) to grayish olive green (5GY 3/2) with olive gray (5Y 3/2) to greenish gray (5GY 6/1) and dark yellowish orange (10YR 6/6) stains; well sorted; consolidated; fractured; firm; damp.					
				TOTAL DEPTH: 16.8'					
	40								

Remarks Logged by: T. Murphy

Checked by: *[Signature]*

Project No.
106P06222

Hydro-Search, Inc.

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INDEX OF DATA

Boring No 34-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

Project: Rocky Flats Plant

LOG OF BORING NO. 34-86

Date Drilled 8/20/86, 8/26/86, 8/28/86

Coordinates N 37171.4 E 23088.4

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5910.44'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL					
				0-1.3'-Sample. Recovered 1.3/1.3'=100%. CLAY: grayish olive (10Y 4/2) to light olive gray (5Y 5/2) silty clay; some sand, gravel and cobbles; subrounded; poorly sorted; grasses at surface; dry.					
	5			2.0-4.0'-Sample. Recovered 1.9/2.0'=95%. SILTY CLAY. moderate to dark yellowish brown (10YR 6/2); white feldspar grains along with quartzite and granite particles; poorly sorted; subangular; few roots; dry.					
				4.0-7.0'-Sample. Recovered 0.0/3.0'=0%.					
	10			7.0-12.0'-Sample. Recovered 2.5/5.0'=50%. CLAYSTONE: olive gray (5Y 4/1); trace silt and sand; gravel lense at 8.6'; grades downward into light olive gray (5Y 5/2) clay; large subrounded cobble at bottom; soft; sticky; damp to moist.					
				12.0-17.0'-Sample. Recovered 2.7/5.0'=54%.					
	15			12.0-16.1'. GRAVEL: light olive gray (5Y 5/2) with abundant pink granite and quartzite; poorly sorted; angular to subangular; some sand; trace clay; wet.					
				ARAPAHOE FORMATION					
	20			16.1-17.0'. CLAYSTONE: dusky yellow (5Y 7/6); abundant medium light gray (N 6) horizontal mottles; well sorted; consolidated; firm; damp.					

Remarks Logged by T Murphy & L Pivonka

Checked by *[Signature]*Project No.
106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 34-86

Date Drilled 8/20/86, 8/26/86, 8/28/86

Coordinates N 37171.4 E 23088 4

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5910 44'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			17.0-22.8'-Sample. Recovered 4.8/4.8'=100%. CLAYSTONE: light olive gray (5Y 5/2) clay with some silt; dark yellowish orange (10YR 6/6) mottles, well sorted; firm; damp.					
	25			22.8-27.8'-Sample. Recovered 5.0/5.0'=100%. CLAYSTONE: light olive gray (5Y 5/2); some silt; some dark yellowish orange (10YR 6/6) mottles; well sorted; firm; damp.					
	30			27.8-32.8'-Sample. Recovered 5.0/5.0'=100%. CLAYSTONE: light olive gray (5Y 5/2) and medium gray (N 5); limonite stains dark yellowish orange (10YR 6/6) abundant; black wood fragments common; trace silt and sand; iron stain along fractures; well sorted; firm; damp.					
	35			32.8-37.8'-Sample. Recovered 5.0/5.0'=100%. CLAYSTONE: olive gray (5Y 3/2) with minor dark yellowish orange (10YR 6/6) limonite stains; black wood fragments common; trace silt and sand; well sorted; firm; damp.					
	40			38.0-43.8'-Sample. Recovered 5.8/5.8'=100%. CLAYSTONE: dark gray (N 3); silty with trace of FeO stringers; some charcoal wood fragments; well sorted; consolidated; damp.					

Remarks Logged by T Murphy & L Pivonka

Checked by *[Signature]*

Project No.

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Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 34-86

Date Drilled 8/20/86, 8/26/86, 8/28/86

Coordinates N 37171 4 E 23088 4

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5910' 44"

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	40			43.8-45.0'-Sample. Recovered 1.2/1.2'=100%. SANDSTONE: dark gray (N 3); clay-rich; greenish gray (5GY 6/1) clay; well sorted; consolidated; damp.					
	45			45.0-48.0'-Sample. Recovered 3.0/3.0'=100%. SANDSTONE: medium gray (N 5) laminated sandstone 0.5" thick with dark gray (N 3) claystone interbeds 0.1" thick; some of the thicker laminae contain coal material; very light gray (N 8) sandy clasts within the lower 1.5'; well sorted; consolidated; damp.					
	50			48.0-52.3'-Sample. Recovered 0.2/4.3'=5%. SANDSTONE: medium light gray (N 6); silty; laminated; well sorted; consolidated; damp.					
	55			52.3-53.4'-Sample. Recovered 1.1/1.1'=100%. SANDSTONE: medium light gray (N 6); silty; laminated; well sorted; consolidated; damp.					
	60			53.4-54.4'-Sample. Recovered 1.0/1.0'=100%. SANDSTONE: medium gray (N 5); laminated; well cemented with calcium carbonate; consolidated; damp.					

Remarks Logged by T Murphy & L Pivonka

Checked by *[Signature]*

Project No.
106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 34-86

Date Drilled 8/20/86, 8/26/86, 8/28/86

Coordinates N 37171.4 E 23088.4

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5910 44'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	60			54.4-55.6'-Sample. Recovered 1.2/1.2'=100%. SANDSTONE: medium gray (N 5); laminated; well cemented with calcium carbonate; consolidated; damp.					
				55.6-59.3'-Sample. Recovered 3.7/3.7'=100%. CLAYSTONE: dark gray (N 3); variable quantities of silt and sand; abundant clay; consolidated; well sorted; firm; moist.					
	65			59.3-62.5'-Sample. Recovered 3.2/3.2'=100%. CLAYSTONE: dark gray (N 3); silty; light gray (N 7) mottling; firm; consolidated; well sorted; moist.					
				62.5-64.5'-Sample. Recovered 2.0/2.0'=100%. SANDSTONE: light gray (N 7) clay laminated sandstone; gradational contact; well sorted; consolidated; moist.					
	70			64.5-69.3'-Sample. Recovered 4.8/4.8'=100%. SANDSTONE: light gray (N 7) and medium light gray (N 6) silty sandstone with trace of wood fossils; sand content increases with depth; consolidated; well sorted; firm; dry.					
	75			69.3-71.0'-Sample. Recovered 1.7/1.7'=100%. CLAYSTONE: medium gray (N 5) silty and fine- grained sandy claystone; well sorted; firm; damp.					
	80								

Remarks Logged by T Murphy & L. Pivonka

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Project No.

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Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 34-86

Date Drilled 8/20/86, 8/26/86, 8/28/86

Coordinates N 37171 4 E 23088.4

Boring Method Hollow Stem Auger/NC Core

Ground Surface Elevation 5910.44'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	80			71.0-74.3'-Sample. Recovered 3.3/3.3'=100%. CLAYSTONE: dark gray (N 3); blocky texture; well sorted; firm; damp.					
				74.3-75.3'-Sample. Recovered 0.6/1.0'=60%. CLAYSTONE: dark gray (N 3); grayish orange (10YR 7/4) mottles; well sorted; consolidated; damp.					
	85			75.3-78.5'-Sample. Recovered 3.2/3.2'=100%. SANDSTONE: medium gray (N 5) silty sandstone, well sorted; consolidated; damp.					
				78.5-83.5'-Sample. Recovered 5.0/5.0'=100%. CLAYSTONE: medium dark gray (N 4); blocky texture; well sorted; consolidated; damp.					
	90			83.5-86.0'-Sample. Recovered 2.5/2.5'=100%. CLAYSTONE: medium dark gray (N 4); blocky texture; trace of pale yellowish orange (10YR 8/6) nodules; well sorted; consolidated; damp.					
				86.0-86.6'-Sample. Recovered 0.6/0.6'=100%. CLAYSTONE: medium dark gray (N 4); blocky texture; trace of pale yellowish orange (10YR 8/6) nodules; well sorted; consolidated; damp.					
	95			86.6-89.0'-Sample. Recovered 2.4/2.4'=100%. CLAYSTONE: greenish gray (5GY 6/1) silty sandstone with clay laminae; well sorted; consolidated; damp.					
	100								

Remarks Logged by T Murphy & L Pivonka

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Hydro-Search, Inc.

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LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 1-87 (cont'd)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By TC Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<p><u>ARAPAHOE FORMATION</u></p> <p>11 75 11.87' SANDSTONE pale yellowish orange (10YR 8/6) to dusky yellowish brown (10YR 2/2), clayey, weathered, moist to wet</p> <p>11.87 12 50' CLAYSTONE light olive gray (5Y 5/2), weathered, trace of iron staining, moist to wet</p>	
25			<p>12 0 15 0' Sample Recovered 3.25/2.0' = 108%</p> <p>CLAYSTONE light olive brown (5Y 5/6), trace caliche, trace dark yellowish orange iron staining (10YR 6/6), weathered, moist to wet</p> <p>TOTAL DEPTH 14 87'</p>	
30				
35				
40				

Project: Rocky Flats Plant

LOG OF BORING NO. 34-86

Date Drilled 8/20/86, 8/26/86, 8/28/86 **Coordinates** N 37171 4 E 23088.4

Boring Method Hollow Stem Auger/NC Core **Ground Surface Elevation** 5910.44'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	100			96.0-100.0'-Sample Recovered 4.0/4.0'=100%. CLAYSTONE: medium dark gray (N 4), gradational contact; some very fine- grained sand; well sorted; consolidated; damp. TOTAL DEPTH: 100.0'					
	105								
	110								
	115								
	120								

Remarks Logged by

Checked by *[Signature]*

Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS

N 37171 4 E 23088 4

ELEVATION GROUND LEVEL

5910 44'

TOP OF CASING

5912 78'

DRILLING SUMMARY

TOTAL DEPTH Well 56 25' Hole 100 00'

BOREHOLE DIAMETER 0.00' - 37.80' 7 1/2"

37 80' - 100 00' 4 3/4"

DRILLER Boyles Brothers Drilling Co

15865 W 5th Avenue, Golden

(David Jarvie, Jim Horn)

RIG Mobile B-57

BIT(S) 0 00' - 37 80' Blade bit

37 80' - 100 00' Bull nose rock bit

DRILLING FLUID None

SURFACE CASING 5" x 40 8' steel w/ locking
Cap

WELL DESIGN

BASIS GEOLOGIC LOG ☒ GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

0 00' 37 80' C1

0 00' 44 24' C2

44 24' 56.25' S1

CASING C1 5" I D steel

C2 2" I D, Sch 5 type 316 stain-
less steel, threaded and flush
jointedSCREEN S1 2" I D, Sch 5 type 316 stain-
less steel, threaded and flush
jointed, 0 010" wire wrap screen,
0 25' welded bottom cap

CENTRALIZERS Type 304 stainless steel

22 47' - 23 70'

49 01' - 50 26'

FILTER MATERIAL 32-42 silica sand

43 00' - 56 50'

CEMENT Portland Type I

0 00' - 42 00', 90 00' - 64 50'

OTHER 3/8" bentonite pellets

42 00' - 43 00'

56.50' - 64.50'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
	7 1/2" auger	8/20 1251	8/20 1545	
	4 3/4" core	8/26 1503	9/2 1202	
GEOPHYS LOGGING	—	—	—	—
CASING				
	5" steel	8/21 0800	8/21 1335	
	2" stainless	9/3 0845	9/3 0900	
FILTER PLACEMENT	9/3	0900	9/3	1145
CEMENTING	9/2	1604	9/2	1716
LEVELCPMENT	9/5	1000	9/12	1015
OTHER				
	Cementing 5" casing	8/21 1359	8/21 1456	
	Lower cement	9/3 1150	9/3 1210	
	Bentonite	9/3 0823	9/3 0845	
		9/3 1145	9/3 1150	
Packer test	8/29	1056	8/29	1725

WELL DEVELOPMENT

See Well Development Summary Sheet

COMMENTS

Water encountered at 48 0' during drilling

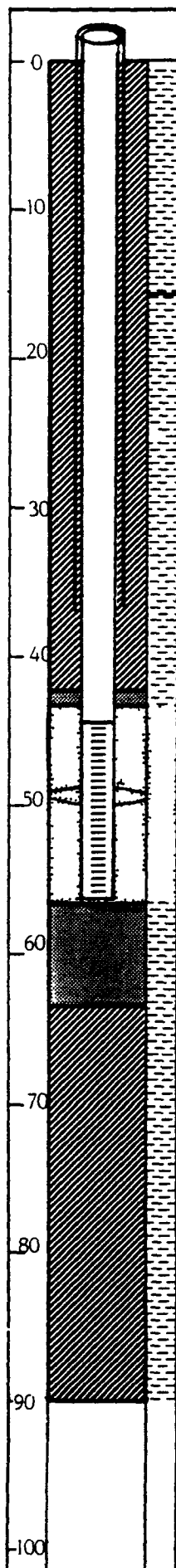
Top of stainless steel casing 2.34'

Cave from T.D. to 90 0'

LOCATION Golden, CO
PERSONNEL T Murphy/L Pivonka

PROJECT 106P06222

Rocky Flats Plant



INDEX OF DATA

Boring No 35-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

Project: Rocky Flats Plant

LOG OF BORING NO. 35-86

Date Drilled 8/19/86

Coordinates N 37177.0 E 23114.4

Boring Method Hollow Stem Auger

Ground Surface Elevation 5909.2

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL ALLUVIUM					
				0-2.0'-Sample. Recovered 2.0/2.0'=100%. CLAY: olive gray (5Y 3/2); dark yellowish orange (10YR 6/6) mottles; grades downward into dark yellowish brown (10YR 4/2) clay, some silt; trace gravel and cobble size clasts of quartzite and granite, subangular to subrounded, dry to damp.					
	5			2.0-2.7'-Sample. Recovered 0.7/0.7'=100%. CLAY: dark yellowish brown (10YR 4/2); dark yellowish orange (10YR 6/6) mottles common, some silt; trace gravel and cobble size clasts of quartzite and granite; subangular to subrounded; dry to damp.					
	10			2.7-3.7'-Sample. Recovered 0.0/0.7'=0%. 3.7-5.7'-Sample. Recovered 2.0/2.0'=100%. 3.7-5.0'. CLAY: dark yellowish brown (10YR 4/2); dark yellowish orange (10YR 6/6) mottles common; some silt; trace gravel and cobble size clasts of quartzite and granite; subangular to subrounded; dry to damp.					
	15			5.0-5.7'. CLAY: light olive gray (5Y 5/2); silty; well sorted; consolidated; firm; damp to moist. 5.7-6.5'. No sample. Depth correction.					
	20			6.5-8.5'-Sample. Recovered 1.7/2.0'=85%. CLAY: olive black (5Y 2/1); silt; trace sand and gravel; moderately well sorted; soft; wet.					

Remarks Logged by T Murphy

Checked by *[Signature]*

Project No.

106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 35-86

Date Drilled 8/19/86

Coordinates N 37177.0 E 23114.4

Boring Method Hollow Stem Auger

Ground Surface Elevation 5909.2

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			8.5-10.5'-Sample. Recovered 2.0/2.0'=100%. CLAY olive black (5Y 2/1) to light olive gray (5Y 5/2); silty with gravel lenses; trace fine-grained sand; poorly sorted; subangular; firm; wet.					
	25			ARAPAHOE FORMATION					
				10.5-12.5'-Sample. Recovered 2.0/2.0'=100%. CLAY light olive gray (5Y 5/2); dark yellowish orange (10YR 6/6) mottles; sand layer at 12.0-12.5', fine-grained; silty; moist; firm.					
	30			12.5-14.0'-Sample. Recovered 1.5/1.5'=100%. CLAYSTONE: light olive gray (5Y 5/2); dark yellowish orange (10YR 6/6) mottles; no gravel; silty; firm; moist.					
				14.0-16.0'-Sample. Recovered 2.0/2.0'=100%. CLAYSTONE: light olive gray (5Y 5/2); dark yellowish orange (10YR 6/6) mottles; no gravel; silty; layers of ironstone; firm; moist.					
	35			16.0-18.0'-Sample. Recovered 1.8/2.0'=90%. CLAYSTONE: pale olive (10Y 6/2) to light olive gray (5Y 5/2); minor dark yellowish orange (10YR 6/6) mottling; apparent bedding due to color variations; firm; damp to moist.					
	40			TOTAL DEPTH: 18.0'					

Remarks Logged by: T Murphy

Checked by: *[Signature]*

Project No.
106P06222

Hydro-Search, Inc.

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WELL CONSTRUCTION SUMMARY

LOCATION or COORDS

N 37177.0 E 23114.4

ELEVATION GROUND LEVEL 5909 20'

TOP OF CASING 5911 54'

DRILLING SUMMARY

TOTAL DEPTH Well 11 60' Hole 18 00'

BOREHOLE DIAMETER 7 1/4"

DRILLER Boyles Brothers Drilling Co.
15865 W 5th Avenue

Golden, CO (Dave Jarvie)

RIG Mobile B-57

BIT(S) T5

DRILLING FLUID None

SURFACE CASING 5" x 5' steel w/ locking
cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

0.00'	4.86'	C1	-
4.86'	11.60'	S1	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

CASING C1 2" I.D. Sch 5 type 316 stain-
C2 less steel, threaded and flush
C3 jointed
C4

SCREEN S1 2" I.D. Sch 5 type 316 stain-
S2 less steel, threaded and flush
S3 jointed, 0 010" wire wrap screen
S4 0 25' welded bottom cap

CENTRALIZERS Type 304 stainless steel
7 80' - 8 85'

FILTER MATERIAL 16-40 silica sand
2.90' - 12.60'

CEMENT Portland Type I
0.00' - 1 95'

OTHER 3/8" bentonite pellets
1 95' - 2 90'
12 60' - 14 20'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE 1986	TIME	DATE 1986	TIME
DRILLING 7 1/4" auger	8/19	1258	8/19	1558
GEOPHYS LOGGING	-	-	-	-
CASING 2" stainless	8/20	1012	8/20	1015
FILTER PLACEMENT	8/20	1015	8/10	1020
CEMENTING	8/20	1025	8/20	1040
DEVELOPMENT	9/3	1000	9/11	1155
OTHER Bentonite	8/20	1020	8/20	1025
	8/20	1008	8/20	1012

WELL DEVELOPMENT

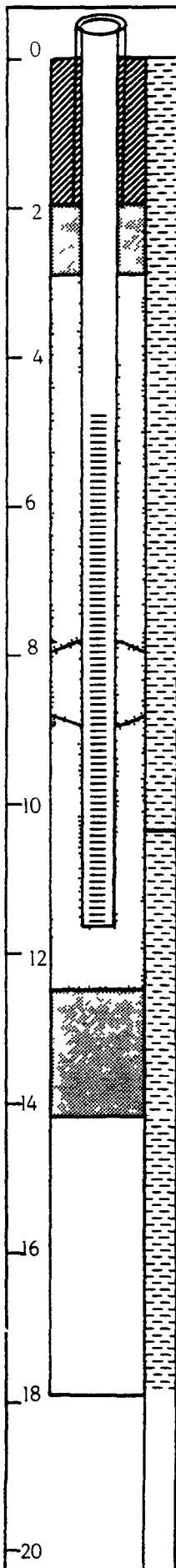
See Well Development Summary Sheet

COMMENTS

Water encountered at 8 0' during drilling

Top of stainless steel casing 2.34'

Cave from TD to 14.20'

LOCATION Golden, CO
PERSONNEL 1 MurphyPROJECT 106P06222
Rocky Flats Plant

INDEX OF DATA

Boring No 36-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project Rocky Flats Plant

LOG OF BORING NO. 36-86

Date Drilled 8/25/86

Coordinates N 37395.4 E 23715.3

Boring Method Hollow Stem Auger

Ground Surface Elevation 5881.94

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	0			VALLEY FILL ALLUVIUM 0-0.3'-Sample. Recovered 0 3/0.3'=100%. CLAY: moderate yellowish brown (10YR 5/4), silty; poorly sorted; unconsolidated, damp. 0.3-4.3'-Sample. Recovered 2.0/4.0'=50%. CLAY: light brown (5YR 5/6) and dark yellowish brown (10YR 4/2); silty; some granitic cobbles, trace iron concretions; poorly sorted; unconsolidated, damp. 4.3-5.5'-Sample. Recovered 0 9/1.2'=75%. GRAVEL dark yellowish brown (10YR 4/2); granitic pebbles and cobbles; silty and clayey, trace iron concretions, poorly sorted, unconsolidated; damp			
	5						
	10			ARAPAHOE FORMATION 5.5-8.0'-Sample. Recovered 2.5/2.5'=100%. CLAYSTONE: medium light gray (N 6) and light olive gray (5Y 4/1); trace iron staining; weathered; consolidated, moist. 8.0-10.2'-Sample. Recovered 2.2/2.2'=100%. CLAYSTONE dark yellowish orange (10YR 6/6); some medium light gray (N 6); sandy with 30-40% iron staining, consolidated; moist			
	15						
	20			TOTAL DEPTH: 10.2'			

Remarks

Logged by L Pivonka

Checked by

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 1

WELL CONSTRUCTION SUMMARY

LOCATION or COORDS _____
N 37395 4 E 23715 3ELEVATION GROUND LEVEL 5881 94'
TOP OF CASING 5883 78'

DRILLING SUMMARY

TOTAL DEPTH Well 6 50' Hole 10 20'
BOREHOLE DIAMETER 7 1/2"
DRILLER Boyles Brothers Drilling Co
15865 W 5th Avenue
Golden, CO (Jim Horn)
RIG Mobile B-57
BIT(S) T-5
DRILLING FLUID None
SURFACE CASING 5' x 5' steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG ☒ GEOPHYSICAL LOG _____
CASING STRING(S) C=CASING S=SCREEN
0 00' - 3 50' C1
3 50' - 6 49' S1
C1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed
S1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed, 0 010" wire wrap screen 0 25' welded bottom cap
CENTRALIZERS Type 304 stainless steel 4.42' - 5.59'
FILTER MATERIAL 32-42 silica sand 2 50' - 7 00'
CEMENT Portland Type I 0 00' - 2 00'
OTHER 3/8" bentonite pellets 2 00' - 2 50'
7 00' - 10 20'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	8/25	1014	8/25	1520
GEOPHYS LOGGING	—	—	—	—
CASING				
2" stainless	8/25	1523	8/25	1525
FILTER PLACEMENT	8/25	1525	8/25	1530
CEMENTING	8/25	1533	8/25	1546
DEVELOPMENT	8/27	1120	9/3	1055
OTHER				
Bentonite	8/25	1530	8/25	1533
	8/25	1520	8/25	1523

WELL DEVELOPMENT

See Well Development Summary Sheet

COMMENTS

No water encountered during drilling

Top of stainless steel casing 1.84'

LOCATION Golden, CO
PERSONNEL L. Pivonka

PROJECT 106P06222

Rocky Flats Plant

PROJECT

INDEX OF DATA

Boring No 43-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project: Rocky Flats Plant

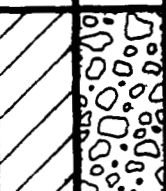
LOG OF BORING NO. 43-86

Date Drilled 9/25/86

Coordinates N 36415.0 E 22761.7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5970.39

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ROCKY FLATS ALLUVIUM 0-1.0'-Sample Recovered 1.0/1.0'=100%. GRAVEL grayish brown (5YR 3/2); 50-60% granitic pebbles and cobbles; 30-40% sand and clay; caliche stringers, poorly sorted; unconsolidated; dry 1 0-3.0'-Sample Recovered 0.0/2.0'=0%. Drilled with center bit in augers 3 0-3.3'-Sample. Recovered 0.2/0.3'=67%. SAND: moderate brown (5YR 4/4), 80% clayey sand; 20% quartzite cobbles; poorly sorted; unconsolidated, dry 3.3-4 0'-Sample Recovered 0.0/0.7'=0%. Drilled with center bit in augers. 4.0-5 4'-Sample. Recovered 1.0/1.4'=74%. SAND pale yellowish brown (10YR 6/2), 60% coarse to fine-grained sand, 10-20% clay; 20% granitic pebbles, poorly sorted; unconsolidated; dry 5.4-5.5'-Sample. Recovered 0.2/0.2'=100%. SAND Same as above; dry 5.5-6.0'-Sample. Recovered 0.0/0.5'=0%. Drilled with center bit in augers. 6.0-8.0'-Sample Recovered 0.9/2.0'=45%. SAND: Same as above, dry.					
	2								
	4								
	6								
	8								

Remarks

Logged by C Walker

Checked by 

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 3

Project: Rocky Flats Plant

LOG OF BORING NO. 43-86

Date Drilled 9/25/86

Coordinates N 36415.0 E 22761.7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5970.39

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	8			8.0-10.0'-Sample Recovered 2.2/2.0'=110%. SAND: moderate brown (5YR 4/4); fine to medium-grained sand; trace coarse-grained sand; poorly sorted; subangular, unconsolidated; dry.					
				10.0-12.0'-Sample Recovered 1.7/2.0'=85%.					
	10			10.0-11.1' SAND Same as above, dry.					
				11.1-12.0'. GRAVEL moderate brown (5YR 4/4), grades downward to coarse to medium-grained sand; poorly sorted; subangular, unconsolidated; damp.					
	12			12.0-14.0'-Sample. Recovered 2.0/2.0'=100% GRAVEL: moderate brown (5YR 4/4); quartzite pebbles and cobbles (20-30%) and coarse-grained sand; poorly sorted; angular to subangular, unconsolidated; damp.					
				14.0-15.5'-Sample. Recovered 0.8/1.5'=53%. GRAVEL: moderate yellowish brown (10YR 5/4), granitic pebbles and cobbles to fine-grained sand; poorly sorted; unconsolidated; dry.					
	14			15.5-16.0'-Sample. Recovered 0.0/0.5'=0%. Drilled with center bit in augers.					
				16.0-16.5'-Sample. Recovered 0.5/0.5'=100%. GRAVEL: Same as above; dry.					
				ARAPAHOE FORMATION					
	16			16.5-18.0'-Sample. Recovered 1.3/1.5'=87%					

Remarks

Logged by C. Walker

Checked by: *JP*

Project No.

106P06222

Hydro-Search, Inc.

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Project: Rocky Flats Plant

LOG OF BORING NO. 43-86

Date Drilled 9/25/86

Coordinates N 36415.0 E 22761.7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5970.39

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	16			16.5-17.0' CLAYSTONE: dark yellowish orange (10YR 6/6) to olive gray (5Y 5/2); consolidated; damp.					
				17.0-17.3' SANDSTONE: yellowish gray (5Y 7/2); fine-grained; friable, moderately sorted; subangular to subrounded; friable; poorly moderately well cemented; damp.					
				17.3-17.8' CLAYSTONE: dark yellowish orange (10YR 6/6) to olive gray (5Y 5/2); consolidated; damp.					
	18			17.8-18.0' SANDSTONE: yellowish gray (5Y 7/2); fine-grained, friable; moderately sorted; subangular to subrounded, poorly cemented; damp.					
				18.0-20.0'-Sample. Recovered 1.5/2.0'=75%.					
				18.0-18.5' CLAYSTONE: dark yellowish orange (10YR 6/6) to olive gray (5Y 5/2); consolidated; damp.					
	20			18.5-20.0' SANDSTONE: yellowish gray (5Y 7/2); fine-grained; friable; moderately sorted; subangular to subrounded; poorly cemented; fractures with dusky yellow brown (10YR 2/2) mottles; damp.					
				20.0-22.0'-Sample. Recovered 2.0/2.0'=100%.					
	22			20.0-20.8' CLAYSTONE: moderate yellowish brown (10YR 5/4) and yellowish gray (5Y 7/2); silty; laminated; poorly consoli- dated; damp.					
				20.8-22.0' SANDSTONE: moderate yellow (5Y 7/6); medium to fine-grained; clayey; moderately sorted; subangular to subrounded; poorly cemented; damp.					
	24			TOTAL DEPTH: 22.0'					

Remarks

Logged by C. Walker

Checked by: *[Signature]*

Project No.

106P06222

Hydro-Search, Inc.

Page 3 of 3

WELL CONSTRUCTION SUMMARY

LOCATION or COORDS

N 36415 0 E 22761 7

ELEVATION GROUND LEVEL 5970 39'

TOP OF CASING 5972 49'

DRILLING SUMMARY

TOTAL DEPTH Well 16 75' Hole 22 00'

BOREHOLE DIAMETER 7 1/2"

DRILLER Boyles Brothers Drilling Co

15865 W 5th Avenue

Golden, CO (Tony Robinson)

RIG Acker

BIT(S) Blade bit and bull nose bit

DRILLING FLUID None

SURFACE CASING 4' x 5" steel w/ locking cap

WELL DESIGN

BASIS GEOLOGIC LOG X GEOPHYSICAL LOG

CASING STRING(S) C=CASING S=SCREEN

0 00' 3.99' C1

3 99' 16 75' S1

CASING C1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed

SCREEN S1 2" I D Sch 5 type 316 stainless steel, threaded and flush jointed, 0 010" wire wrap screen
0.25' welded bottom capCENTRALIZERS Type 304 stainless steel
9.61' - 10.80'FILTER MATERIAL 32-42 silica sand
3 00' - 16 80'CEMENT Portland Type I
0.00' - 2 10'OTHER 3/8" bentonite pellets
2 10' - 3 00'
16 80' - 17.20'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
7 1/2" auger	9/25	1645	9/26	1305
GEOPHYS. LOGGING	—	—	—	—
CASING				
2" stainless	9/26	1453	9/26	1500
FILTER PLACEMENT	9/26	1500	9/26	1520
CEMENTING	9/26	1526	9/26	1540
DEVELOPMENT	10/10	0820	10/10	0820
OTHER				
Bentonite	9/26	1520	9/26	1526
	9/26	1445	9/26	1453

WELL DEVELOPMENT

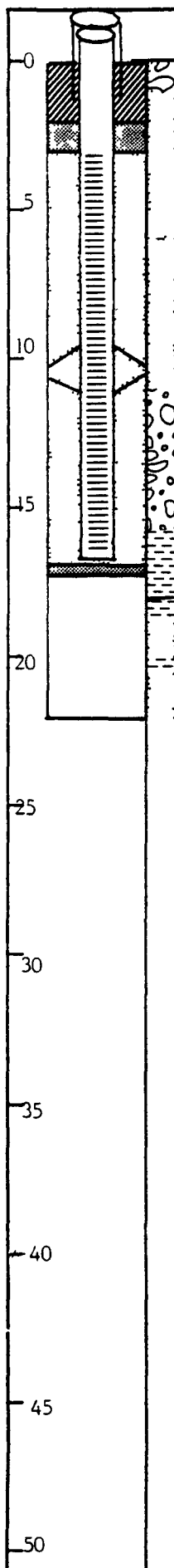
See Well Development Summary Sheet

COMMENTS

No water encountered during drilling

Top of stainless steel casing 2 10'

Cave from TD to 17.20'

LOCATION Golden, CO
PERSONNEL C. WalkerPROJECT 106P06222
Rocky Flats Plant

INDEX OF DATA

Boring No 44-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

Project. Rocky Flats Plant

LOG OF BORING NO. 44-86

Date Drilled 11/6/86

Coordinates N 36252.4 E 19130.5

Boring Method Hollow Stem Auger

Ground Surface Elevation 6019 93'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Foot)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ROCKY FLATS ALLUVIUM					
				0.0-1.4'-Sample. Recovered 0.8/1.4'=57%. TOP SOIL: moderate brown (5YR 4/4); silty clay; abundant fine to coarse- grained gravel and small cobbles; moist.					
	5			1.4-5.0'-Sample. Recovered 0.8/3.6'=22%. CLAY: same as above; moist					
				5.0-8.0'-Sample. Recovered 0.9/3.0'=30%. CLAY: same as above; wet.					
	10			8.0-10.5'-Sample. Recovered 1.1/2.5'=44%. SANDY CLAY dark yellowish brown (10YR 4/2); silty; gravel and small cobbles; wet.					
				10.5-12.0'-Sample. Recovered 0.8/1.5'=53%. SANDY CLAY: same as above with some FeO stains; wet.					
	15			12.0-15.5'- No sample recovered. Cuttings indicate cobbles; clay; silt; very wet.					
				15.5-18.0'-Sample. Recovered 2.5/2.5'=100%. SILTY CLAY: light brown (5YR 6/6); abundant FeO stains and mottling; wet.					
	20			18.0-20.5'-Sample. Recovered 2.5/2.5'=100%. CLAY: light brown (5YR 6/6); silty, sandy micaceous clay, abundant FeO; wet.					

Remarks

Logged by L Pivonka

Checked by: Project No
106P06222

Hydro-Search, Inc.

Page 1 of 2

Project		Rocky Flats Plant		<h2 style="margin: 0;">LOG OF BORING NO. 44-86</h2>			
Date Drilled		11/6/86		Coordinates N 36252 4 E 19130.5			
Boring Method		Hollow Stem Auger		Ground Surface Elevation 6019 93'			

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Foot) 20 40	Water Content (%) 20 40	Other Tests
	20			20.5-23.0'-Sample. Recovered 2.5/2.5'=100%. SANDY CLAY: light brown (5YR 5/6); micaceous; trace medium-grained gray quartzite gravel, mottled; wet.			
				23.0-25.5'-Sample. Recovered 2.5/2.5'=100%. SANDY CLAY: same as above; wet.			
	25			ARAPAHOE FORMATION			
				25.5-30.5'-Sample. Recovered 4.3/5.0=86%. CLAYSTONE: light olive gray (5Y 6/1); blocky, greasy; abundant FeO mottles; moist to wet.			
	30			30.5-33.0'-Sample. Recovered 1.2/2.5'=48%. CLAYSTONE: same as above; moist to wet.			
				TOTAL DEPTH: 33.0'			
	35						
	40						

Remarks	Logged by L. Pivonka	Checked by
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Project No. 106P06222	Hydro-Search, Inc.	Page 2 of 2
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INDEX OF DATA

Boring No 61-86

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

Project Rocky Flats Plant

LOG OF BORING NO. 61-86

Date Drilled 11/19/86

Coordinates N 36217.4 E 20608.7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5999.31'

Elev (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Foot)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ROCKY FLATS ALLUVIUM 0.0-2.5'-Sample. Recovered 2.0/2.5'=80%. TOP SOIL: dark yellowish brown (10YR 4/2); silty; clay-rich; abundant small cobbles and coarse gravel; disturbed; moist.					
	5			ARAPAHOE FORMATION 2.5-5.0'-Sample. Recovered 2.2/2.5'=88%. CLAYSTONE: yellowish gray (5Y 8/1); white (N 9/0) greasy clay with abundant CaCO ₃ occurring throughout; some medium-grained sand in lower 1.0'; FeO stained; moist.					
	10			5.0-11.5'-Sample. Recovered 4.0/6.5'=62%. CLAYSTONE: yellowish gray (5Y 8/1); dark yellowish brown (10YR 4/2) clays, silts, sands, gravels, and small cobbles; top soil; moist; wet at 8.0' with heavy FeO stains.					
	15			11.5-13.5'-Sample. Recovered 2.0/2.0'=100%. CLAYSTONE: dark yellowish orange (10 YR 6/6); greasy; undisturbed; blocky; moist.					
				13.5-18.5'-Sample. Recovered 4.0/5.0'=80%. CLAYSTONE: dark yellowish orange (10YR 6/6); light olive gray (5Y 6/1); blocky; greasy; bedded; moist.					
	20			TOTAL DEPTH: 18.5'					

Remarks

Logged by L Pivonka

Checked by: 

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 1

WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS _____
 N 36217 5 E 20608.7

 ELEVATION GROUND LEVEL 5999.31'
 TOP OF CASING 6000.76'

DRILLING SUMMARY

 TOTAL DEPTH Well 12 25' Hole 18 50'
 BOREHOLE DIAMETER 7 1/4"
 DRILLER Boyles Brothers Drilling Co
15865 W 5th Avenue
Golden, CO (Jim Horn)
 RIG Mobile B-57
 BIT(S) Blade bit
 DRILLING FLUID None
 SURFACE CASING 5" x 4' steel w/ locking cap

WELL DESIGN.

 BASIS GEOLOGIC LOG X GEOPHYSICAL LOG _____
 CASING STRING(S) C=CASING S=SCREEN

DEPTH	CASING	SCREEN
0.00' - 5.00'	CI	-
5.00' - 12.00'	SI	-
12.00' - 18.50'	-	-
18.50' - 25.00'	-	-
25.00' - 30.00'	-	-
30.00' - 35.00'	-	-
35.00' - 40.00'	-	-
40.00' - 45.00'	-	-
45.00' - 50.00'	-	-

 CASING CI 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.
 SCREEN SI 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrapped screen, 0.25' welded bottom cap.
 CENTRALIZERS Type 304 stainless steel
7.84' - 9.01'
 FILTER MATERIAL 32-42 silica sand
4.00' - 12.50'
 CEMENT Portland Type I
0.00' - 3.00'
 OTHER 3/8" bentonite pellets
3.00' - 4.00'
12.50' - 18.50'

CONSTRUCTION TIME LOG

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	1986		1986	
<u>7 1/4" auger</u>	<u>11/19</u>	<u>1157</u>	<u>11/19</u>	<u>1247</u>
GEOPHYS. LOGGING.	-	-	-	-
CASING				
<u>2" stainless</u>	<u>11/19</u>	<u>1429</u>	<u>11/19</u>	<u>1431</u>
FILTER PLACEMENT	<u>11/19</u>	<u>1427</u>	<u>11/19</u>	<u>1435</u>
CEMENTING	<u>11/19</u>	<u>1436</u>	<u>11/19</u>	<u>1447</u>
LEVELCPMENT				
OTHER				
<u>Bentonite</u>	<u>11/19</u>	<u>1435</u>	<u>11/19</u>	<u>1436</u>
	<u>11/19</u>	<u>1425</u>	<u>11/19</u>	<u>1427</u>

WELL DEVELOPMENT

See Well Development Summary Sheet.

COMMENTS:

Water encountered at 8.50' during drilling.
Top of stainless steel casing: 1.45'

1987 MONITOR WELLS

INDEX OF DATA

Boring No 1-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant, 881 Hillside
Coordinates N35145.6 E20540.6
Total Depth 14.87'

Borehole/Well No 1-87
Ground Surface Elevation 5992.35'
Water Level Encountered 11.75'
Static 5981.29' (6/24/87)
Driller R. Sharp
Helper A. Snade
Drilling Fluid None
Checked By [Signature]
Site Manager
CEARP Manager

Drilling Company Boyles Bros
Date Drilled May 8, 1987
Drilling Method Hollow Stem Auger
Logged By K. D. Hollaway
Geologist

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			ROCKY FLATS ALLUVIUM (DISTURBED) <i>Artificial Fill</i>	HNu Background = 0.3ppm No OVA readings No readings above background
0-4.0'			Sample Recovered 1.65/4.0' = 41% CLAY dark yellowish brown (10YR 4/2), occasional quartzite cobbles and gravel, unconsolidated, damp to moist	
4.0-7.5'			Sample Recovered 3.0/3.5' = 86% CLAY same as above, dark yellowish orange (10YR 6/6) stains common, damp to moist	
7.5-12.5'			Sample Recovered 1.15/5.0' = 23% 6.85-7.35' CLAY same as above 7.35-7.50' Lost core 7.50-8.20' CLAY same as above, trace sand (2.0-1.50); very pale orange (10YR 5/4), subrounded; moderate reddish brown (10R 4/6) stains; moist 8.20-8.70' CLAY moderate brown (5YR 4/6) to moderate yellowish brown (10YR 5/4); weathered, unconsolidated; moist.	
8.70'			COBBLE; quartzite, dusky yellowish brown (10YR 2/2), clay matrix	
8.70'-11.75'			Lost core	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 1-87 (cont'd)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By JPasalle
Site Manager
TC
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<p><u>ARAPAHOE FORMATION</u></p> <p>11 75 11 87' SANDSTONE pale yellowish orange (10YR 8/6) to dusky yellowish brown (10YR 2/2), clayey, weathered, moist to wet</p> <p>11 87 12.50' CLAYSTONE light olive gray (5Y 5/2), weathered, trace of iron staining, moist to wet</p>	
25			<p>12.0-15.0' Sample Recovered 3.25/2.0' = 108% CLAYSTONE light olive brown (5Y 5/6), trace caliche, trace dark yellowish orange iron staining (10YR 6/6), weathered, moist to wet</p> <p>TOTAL DEPTH 14.87'</p>	
30				
35				
40				

WELL COMPLETION INFORMATION

Location ROCKY FLATS PLANT 881 HILLSIDE
 Coordinates N35145.5971 E20540.5926
 Total Depth Well 12.08'
 Borehole 14.87'

Well No. 1-87
 Elevation Ground Surface 5992.35'
 Top of Casing 5994.23'

Formation of Completion ROCKY FLATS ALLUVIUM

Casing Material SCH 5, TYPE 316, TEL STAINLESS Casing Diameter 2" ID

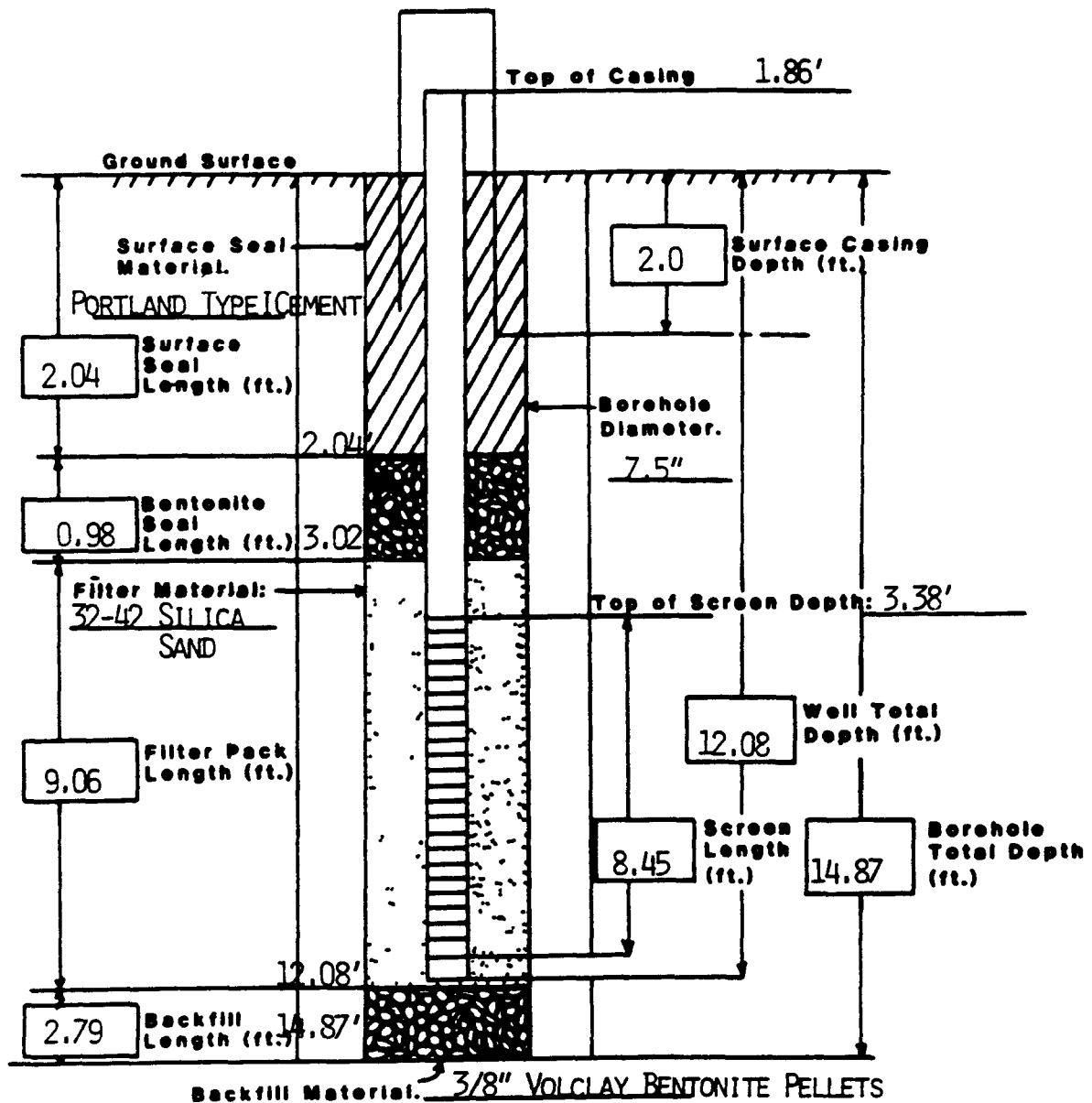
Screen Material 0.010" WIRE WRAP, TYPE STEEL Surface Casing Diameter 5" ID

Date Installed MAY 8, 1987 316, STAINLESS Approved By [Signature]

Installed By K.D. HOLLIWAY STEEL Site Manager
 Geologist

CEARP Manager

Comments _____



INDEX OF DATA

Boring No 9-87/BH29-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant; 903 Pad Area
Coordinates N 36080.84 E 22239.33
Total Depth 37.50'

Borehole/Well No 9-87BR/BH29-87
Ground Surface Elevation 5980.22'
Water Level Encountered 17.50'
Static 5963.42' (12/01/87)

Drilling Company Boyles Bros
Date Drilled June 12, 1987
Drilling Method Hollow Stem Auger
Logged By J. B. Bergman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>TOPSOIL</u>	
			<u>0.0-1.5' SAMPLE.</u> Recovered 1 45/1 5' = 76% 0 0 - 0 5' TOP SOIL grayish brown (5 YR 3/2), abundant roots and grasses, sandy clay and gravel, unconsolidated, dry	HNu Background=0 6 OVA Background=0 8 No readings over background
5			<u>ROCKY FLATS ALLUVIUM</u>	
			0 5 - 1 45' COBBLES AND GRAVEL pink and gray quartzite and granite in a clay matrix, pale yellowish brown (10 YR 6/2), unconsolidated, angular, dry	5.0' Field screen readings HNu = 0 8 (BG), OVA=1 8 (BG)
10			<u>1.5-3.0' SAMPLE.</u> Recovered 1 65/1 5' = 110% CLAYEY GRAVEL pink and gray granite and quartzite in a moderate yellowish brown (10 YR 5/4) matrix, sandy, unconsolidated, unsorted, dry	9.70-12.70' Contact sample BH298713CT 10.0' Field screen readings HNu = 0 8 (BG), OVA = 1 8 (BG)
			<u>3.0-4.2' SAMPLE.</u> Recovered 1 0/1.2' = 83% CLAYEY GRAVEL same as above, dry	15.0' Field screen readings HNu = 0 8 (BG), OVA = 1 8 (BG)
15			<u>4.2-5.0' SAMPLE.</u> Recovered 1 5/0 8' = 188% CLAYEY GRAVEL same as above, dry	15.70-16.80' Bedrock sample BH298716BR
			<u>5.0-6.0'</u> No recovery Lost core	17.50-18.50' Water table sample BH298717WT
20			<u>6.0-7.5' SAMPLE.</u> Recovered 0 6/1 5' = 40% SILT pale yellowish brown (10 YR 6/2), quartzite cobble, distorted sample (cuttings from center bit), dry	20.0' Field screen readings HNu = 0 2 (BG), OVA = 1 8 (BG)

LOG
OF
BOREHOLE

Location Rocky Flats Plant; 903 Pad Area
Coordinates N 36080.84 E 22239.33
Total Depth 37.50'

Borehole/Well No 9-87BR/BH29-87
Ground Surface Elevation 5980.22'
Water Level Encountered 17.50'
Static 5963.42' (12/01/87)

Drilling Company Boyles Bros
Date Drilled June 12, 1987
Drilling Method Hollow Stem Auger
Logged By J. B. Bergman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>7.5-9.5' SAMPLE.</u> Recovered 20/20' = 100% SAND AND GRAVEL moderate yellowish brown (10 YR 5/4), abundant quartzite and granite, unconsolidated, medium-grained sand, angular to sub-rounded, dry	
25			<u>9.5-12.5' SAMPLE.</u> Recovered 20/30' = 67% SAND AND GRAVEL same as above, moist	<u>25.0'</u> Field screen readings HNu = 02 (BG), OVA = 18 (BG)
			<u>12.5-15.0' SAMPLE</u> Recovered 20/25' = 80% 12.5-12.7' SAND AND GRAVEL same as above, moist	
30			<u>ARAPAHOE FORMATION</u>	
			12.7-13.8' SANDSTONE light brown (5 YR 6/4), very fine grained, rounded, well sorted, wet	<u>30.0'</u> Field screen readings HNu = 02 (BG), OVA = 18 (BG)
			13.8-14.5' SANDSTONE pale yellowish brown (10 YR 6/2), quartzose, coarse grained, well sorted, rounded, moist	
35			<u>15.0-17.5' SAMPLE.</u> Recovered 18/25' = 72% SANDSTONE yellowish gray (5 Y 8/1), well sorted, medium grained, consolidated, moist	<u>35.0'</u> Field screen readings HNu = 02 (BG), OVA = 18 (BG)
40			<u>17.5-20.0' SAMPLE</u> Recovered 20/25' = 80% SANDSTONE same as above, wet at 17.5', clay layer olive gray (5 Y 3/2) at 18.0-18.5', wet	

LOG
OF
BOREHOLE

Location Rocky Flats Plant; 903 Pad Area

Coordinates N 36080.84 W 22239.33

Total Depth 37.50'

Drilling Company Boyles Bros

Date Drilled June 12, 1987

Drilling Method Hollow Stem Auger

Logged By J. B. Bergman
Geologist

Borehole/Well No 9-87BR/BH29-87

Ground Surface Elevation 5980.22'

Water Level Encountered 17.50'

Static 5963.42' (12/01/87)

Driller R. Sharp

Helper T. Merritt

Drilling Fluid None

Checked By _____
Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>20.0-22.5' SAMPLE.</u> Recovered 1 5/2 5' = 60% SANDSTONE pale olive (10 Y 6/2), medium-grained, well sorted, few moder- ate yellowish brown (10 YR 5/4) stains, rounded, wet	
			<u>22.5-25.0' SAMPLE</u> Recovered 1 5/2 5' = 60% SANDSTONE same as above, wet	
			<u>25.0-27.5' SAMPLE.</u> Recovered 2 2/2 5' = 88% SANDSTONE same as above, wet	
			<u>27.5-30.0' SAMPLE.</u> Recovered 0/2 5' = 0%	
			<u>30.0-32.5' SAMPLE.</u> Recovered 2 5/2 5' = 100% 30 0-30 5' SANDSTONE same as above 30 5-31 5' SANDSTONE moderate brown (5 YR 4/4), chert and quartzite, very coarse-grained, well to moderate sorting, wet 31 5-31 7' CLAYSTONE light olive gray (5 Y 5/2), sandy, consolidated, moist 31 7-31 9' SANDSTONE light olive gray (5 Y 5/2), and moderate brown (5 YR 4/4), well sorted, wet 31 9-32 5' CLAYSTONE light olive gray (5 Y 5/2), sandy, consolidated, moist	

LOG
OF
BOREHOLE

Location Rocky Flats Plant, 903 Pad Area
Coordinates N 36080 84 W 22239.33
Total Depth 37 50'

Borehole/Well No 9-87BR/BH29-87
Ground Surface Elevation 5980.22'
Water Level Encountered 17.50'
Static 5963.42' (12/01/87)

Drilling Company Boyles Bros
Date Drilled June 12, 1987
Drilling Method Hollow Stem Auger
Logged By J. B. Bergman
Geologist

Driller R. Sharp

Helper T. Merritt

Drilling Fluid None

Checked By _____
 Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>32.5-35.0' SAMPLE</u> Recovered 2 8/2 5' = 112% CLAYSTONE light brown (5 YR 5/6) and light olive gray (5 Y 5/2), some light brown (5 YR 5/6), mottles, consolidated, trace organics, moist	
			<u>35.0-37.5' SAMPLE</u> Recovered 2 5/2 5' = 100% CLAYSTONE same as above, sandy in top 0 5' and in shoe, moist	
			TOTAL DEPTH 37 50'	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, 903 Pad Area

Coordinates N 36080.84 E 22239.33

Total Depth Well 32.40'

Borehole 37 50'

Well No 9-87BR

Elevation Ground Surface 5980.22'

Top of Casing 5981 72'

Formation of Completion Arapahoe Formation

Casing Material Sch 5, type 316 TFJ stainless steel

Casing Diameter 2" ID

Screen Material 0.010" wire wrap, type 316 TFJ stainless steel

Surface Casing Diameter 5" ID

Date Installed June 15, 1987

Approved By _____

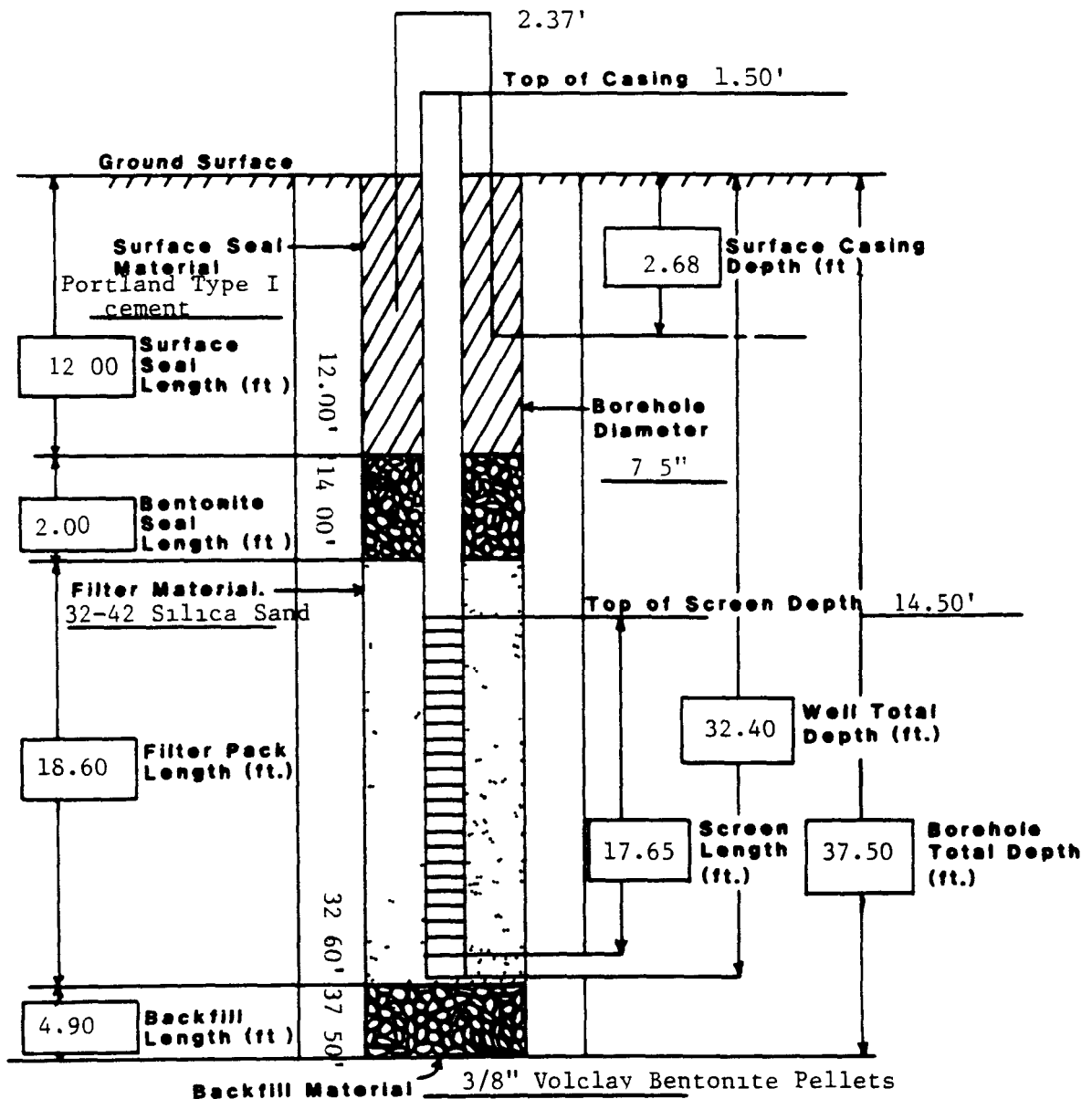
Installed By J B Bergman

Site Manager

Geologist

CEARP Manager

Comments _____



INDEX OF DATA

Boring No 10-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant; 903 Pad Area
Coordinates N 35259.99 E 22180.04
Total Depth 17.00'

Borehole/Well No 10-87
Ground Surface Elevation 5981.96'
Water Level Encountered None
Static 5970.68'

Drilling Company Boyles Bros
Date Drilled June 15, 1987
Drilling Method Hollow Stem Auger
Logged By C. J. Wood
Geologist

Driller D. Jarvie
Helper K. Parker
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>ROCKY FLATS ALLUVIUM</u>	
			<u>0.0-2.0' SAMPLE.</u> Recovered 10/20' = 50% SANDY CLAY moderate brown (5 YR 4/4), numerous quartzite pebbles and cobbles, some roots, dry	HNu Background=00 OVA Background=00 Ludlum Background = 00 No readings over background
5			<u>2.0-4.0' SAMPLE.</u> Recovered 06/20' = 30% GRAVELS quartzite pebbles and cobbles, dry	
			<u>4.0-5.0' SAMPLE.</u> No recovery Lost core	
10			<u>5.0-7.0' SAMPLE.</u> Recovered 20/20' = 100% SANDY CLAY light olive gray (5 Y 6/1) to moderate reddish orange (10 R 6/6), highly weathered, calcite throughout, numerous quartzite pebbles and cobbles, unconsolidated, damp	
15			<u>7.0-9.0' SAMPLE.</u> Recovered 20/20' = 100% SAND light gray (N 7/0) to moderate reddish orange (10 R 6/6), with some clay, numerous quartzite pebbles subangular to subrounded, caliche throughout, damp to dry	
20				

LOG
OF
BOREHOLE

Location Rocky Flats Plant; 903 Pad Area
Coordinates N 35959 99 E 22180.04
Total Depth 17.00'

Borehole/Well No 10-87
Ground Surface Elevation 5981 96'
Water Level Encountered None
Static 5970.68'

Drilling Company Boyles Bros
Date Drilled June 15, 1987
Drilling Method Hollow Stem Auger
Logged By C. J. Wood
Geologist

Driller D. Jarvie
Helper K. Parker
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>9.0-11.0' SAMPLE.</u> Recovered 1 5/20' = 75% 9.0-10.5' SAND moderate reddish orange (10 R 6/6), weathered, numerous quartzite pebbles, medium to coarse grained, trace caliche, damp	
			<u>ARAPAHOE FORMATION</u>	
			<u>11.0-13.0' SAMPLE.</u> Recovered 20/20' = 100% SILTY CLAYSTONE moderate reddish orange (10 R 6/6), iron staining, light gray (N 7/0) in areas, damp to dry	
			<u>13.0-15.0' SAMPLE.</u> Recovered 20/20' = 100% SANDY-SILTY CLAYSTONE moderate reddish orange (10 R 6/6), iron staining, light gray areas (N 7/0), damp	
			<u>15.0-17.0' SAMPLE.</u> Recovered 20/20' = 100% SANDY-SILTY CLAYSTONE light gray (N 7/0) to moderate reddish orange (10 R 6/6), trace calcite, dry to damp	
			TOTAL DEPTH 17.00'	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, 903 Pad Area

Coordinates N 35959.99 E 22180.04

Total Depth Well 12.00'

Borehole 17.00'

Formation of Completion Rocky Flats Alluvium

Casing Material Sch 5, type 316 TFJ stainless steel

Screen Material 0.010" wire wrap, type 316 TFJ stainless steel

Date Installed June 15, 1987

Installed By C.J. Wood
Geologist

Well No 10-87

Elevation Ground Surface 5981.96'

Top of Casing 5983.53'

Casing Diameter 2" ID

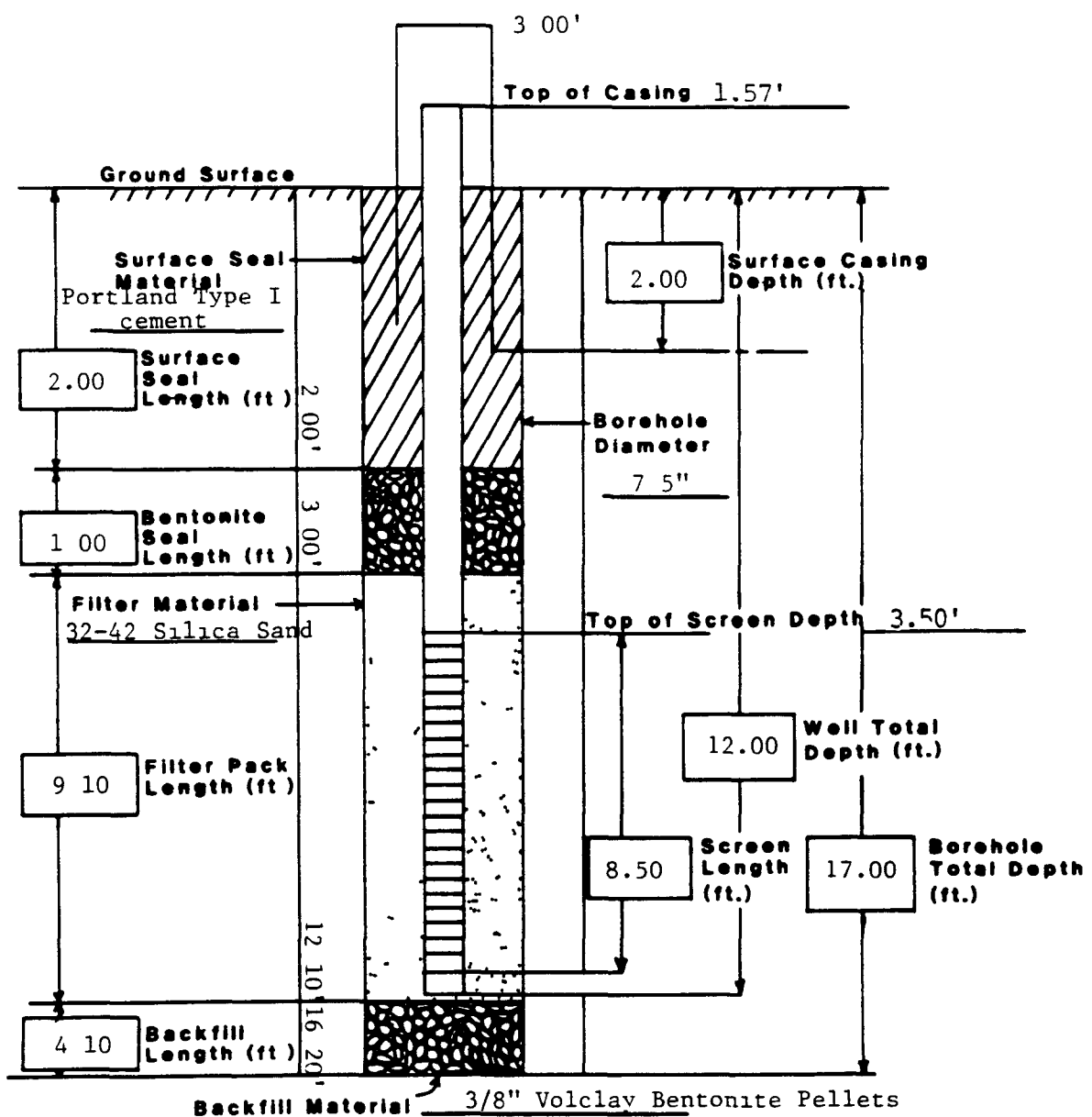
Surface Casing Diameter 5" ID

Approved By _____

Site Manager

CEARP Manager

Comments Centralizer at 7.35 to 8.50'



INDEX OF DATA

Boring No 10-87BRA

Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

LOG OF BOREHOLE

Location Rocky Flats Plant; 903 Pad Area

Coordinates _____

Total Depth 53.00'

Drilling Company Boyles Bros

Date Drilled June 12, 1987

Drilling Method Hollow Stem Auger

Logged By C. J. Wood
Geologist

Borehole/Well No 10-87BRA

Ground Surface Elevation _____

Water Level Encountered 28.30'

Static N/A

Driller D. Jarvie

Helper K. Parker

Drilling Fluid None

Checked By _____
Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I cement

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ROCKY FLATS ALLUVIUM</u>	
			<u>0-2.0' SAMPLE.</u> Recovered 1 2/2 0' = 60% SANDY CLAY dusky brown (5 YR 2/2), some quartzite pebbles and cobbles, some caliche throughout, damp	HNu Background=00 OVA Background=00 Ludlum Background = 00 No readings over background
5			<u>2.0-4.0' SAMPLE</u> Recovered 2 0/2 0' = 100% SANDY GRAVELS moderate brown (5 YR 3/4), some clay, some quartzite peb- bles, trace caliche, very unconsolidated, subangular to subrounded	
10			<u>4.0-8.0' SAMPLE.</u> Recovered 0 8/4 0' = 20% SANDY GRAVELS moderate brown (5 YR 4/4), some clay, some quartzite peb- bles and cobbles, trace caliche, damp	
15			<u>8.0-10.0' SAMPLE.</u> Recovered 2 3/2 0' = 115% SAND moderate reddish brown (10 R 4/6), some caliche, some clay, trace iron staining, moderate reddish orange (10 R 6/6), damp	
20			<u>10.0-13.0' SAMPLE.</u> Recovered 0 4/3 0' = 130% SAND moderate reddish brown (10 R 4/6), some clay, some caliche, trace mod- erate reddish orange (10 R 6/6) iron stains, damp	

LOG OF BOREHOLE

Location Rocky Flats Plant, 903 Pad Area

Coordinates

Total Depth 53.00'

Drilling Company Boyles Bros

Date Drilled June 12, 1987

Drilling Method Hollow Stem Auger

Logged By C. J. Wood
Geologist

Borehole/Well No 10-87BRA

Ground Surface Elevation

Water Level Encountered 28.30'

Static N/A

Driller D. Jarvie

Helper K. Parker

Drilling Fluid None

Checked By
Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I cement

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>13.0-16.0' SAMPLE.</u> Recovered 1 2/3 0' = 40% SANDY CLAY light olive gray (5 Y 6/1) with moderate reddish orange (10 R 6/6) iron stains, some quartzite cobbles, damp <u>ARAPAHOE FORMATION</u>	
25			<u>16.0-18.3' SAMPLE.</u> Recovered 2 8/23' = 121% CLAYSTONE dark yellowish orange (10 YR 6/6), iron staining streaks of moderate reddish orange (10 R 6/6)	
30			<u>18.3-20.8' SAMPLE.</u> Recovered 3 0/25' = 120% CLAYSTONE olive gray (5 Y 3/2) with moderate reddish orange (10 R 6/6) streaks, sandy, slightly damp	
			<u>20.8-23.3' SAMPLE.</u> Recovered 2 0/25' = 80% CLAYSTONE dark yellowish orange (10 YR 6/6), weathered, iron staining, moderate reddish orange (10 R 6/6)	
			<u>23.3-28.3' SAMPLE.</u> Recovered 2 0/50' = 40% CLAYSTONE medium gray (N 6/0), slightly sandy, weathered, moderate reddish orange (10 R 6/6) iron stains, damp	
35			<u>28.3-30.3' SAMPLE.</u> Recovered 0 9/20' = 45%. CLAYSTONE medium gray (N 6/0) to olive gray (5 Y 3/2) with moderate reddish orange (10 R 6/6) iron staining streaks, wet	
40				

LOG
OF
BOREHOLE

Location Rocky Flats Plant; 903 Pad Area

Coordinates _____

Total Depth 53.00'

Borehole/Well No 10-87BRA

Ground Surface Elevation _____

Water Level Encountered 28 30'

Static N/A

Drilling Company Boyles Bros

Date Drilled June 12, 1987

Drilling Method Hollow Stem Auger

Logged By C. J. Wood

Driller D. Jarvie

Helper K Parker

Drilling Fluid None

Checked By _____

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I cement

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
40			TOTAL DEPTH WITH PLOPPER 31 0', READJUST DEPTH	
			<u>31.0-36.0' SAMPLE.</u> Recovered 4 0/5 0' = 80% CLAYSTONE light brown (5 Y 5/6) to very light gray (N 8/0), weathered, iron staining moderate reddish orange (10 R 6/6), wet	
45			<u>36.0-40.0' SAMPLE</u> Recovered 1 7/4 0' = 42% CLAYSTONE moderate brown (5 YR 4/4), some iron staining moderate reddish orange (10 R 6/6), wet	
			<u>40.0-44.0' SAMPLE.</u> Recovered 5 0/4 0' = 125% CLAYSTONE same as above	
50			<u>44.0-48.0' SAMPLE.</u> Recovered 2 0/4 0' = 50% CLAYSTONE light brown (5 YR 5/6), wea- thered, with iron staining streak, moderate reddish orange (10 R 6/6), wet	
			<u>48.0-50.4' SAMPLE.</u> Recovered 2 0/2 4' = 83% CLAYSTONE dark gray (N 3/0), moist	
55			<u>50.6-53.0' SAMPLE.</u> CLAYSTONE dark gray (N 3/0) , small lignite layer (coal) about 1/8" thick, moist to wet	
			TOTAL DEPTH 53 00'	

INDEX OF DATA

Boring No 19-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36633.42 E 23064.85
Total Depth 16.10'

Borehole/Well No 19-87
Ground Surface Elevation 5967.98'
Water Level Encountered None
Static 5958.07' (12/01/87)

Drilling Company Boyles Bros
Date Drilled August 5, 1987
Drilling Method Hollow Stem Auger
Logged By J.R. Bergman
Geologist

Driller T. Merritt
Helper J. Duncan
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ROCKY FLATS ALLUVIUM</u>	
			<u>0.0-2.0' SAMPLE</u> Recovered 14/20' = 70% CLAY AND GRAVEL grayish brown (5 YR 3/2), abundant gray quartzite cobbles, pebbles and gravels, some roots and grasses, poorly sorted, unconsolidated, some caliche-reacts strongly with HCl, slightly damp	HNu Background=0.4 OVA Background=0.0 No Ludlum readings taken
5			<u>2.0-4.0' SAMPLE</u> Recovered 19/20' = 95% CLAY AND GRAVEL pale yellowish brown (10 YR 6/2), clay, abundant caliche-strongly reacts with HCl, abundant quartzite pebbles and cobbles, angular, poorly sorted, unconsolidated, dry to slightly damp	<u>2.0-4.0' Readings on core HNu = 0.2-2.0, OVA = 0.0</u> <u>4.0-5.3' Readings on core HNu = 1-100, OVA = 0.0</u>
10			<u>4.0-5.3' SAMPLE</u> Recovered 19/13' = 146% CLAY AND GRAVEL same as above with some moderate brown (5 YR 3/4) clay patches, dry	<u>8.1-11.1' Readings on core HNu=0.4-1.2, OVA=0.0-2.0</u>
15			<u>5.3-6.0' SAMPLE</u> Recovered 07/07 = 100% CLAY AND GRAVEL same as above, dry	<u>14.1-16.1' Readings on core HNu=2, OVA=1.2</u>
20			<u>6.0-8.1' SAMPLE</u> No recovery Drilled with center bit	

LOG
OF
BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36633.42 E 23064.85
Total Depth 16.10'

Borehole/Well No 19-87
Ground Surface Elevation 5967.98'
Water Level Encountered None
Static 5958.07' (12/01/87)

Drilling Company Boyles Bros
Date Drilled August 5, 1987
Drilling Method Hollow Stem Auger
Logged By J.R. Bergman
Geologist

Driller T. Merritt
Helper J. Duncan
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>8.1-11.1' SAMPLE</u> Recovered 30/30' = 100% SANDY CLAY AND GRAVEL moderate brown (5 YR 3/4) and light brown (5 YR 5/6), sandy clay matrix with abundant quartzite gravels, poorly sorted, very fine-grained, unconsolidated, dry	
			<u>11.1-14.1' SAMPLE</u> Recovered 30/30' = 100% 11.1-11.4' CLAY olive gray (5 Y 3/2), abundant caliche-reacts strongly with HCl, trace moderate yellowish brown (10 YR 5/4) clay patches, trace angular pebbles and gravels, dry	
			<u>ARAPAHOE FORMATION</u> 11.4-14.1' CLAYSTONE olive gray (5 Y 3/2), some moderate brown (10 YR 5/4) mottles, abundant CaCO ₃ concretions, white-reacts strongly with HCl, some black organics, dry	
			<u>14.1-16.1' SAMPLE</u> Recovered 20/20' = 100% CLAYSTONE same as above, dry	
			TOTAL DEPTH 16.10'	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant; Mound Area

Coordinates N 36633.42 E 23064.85

Total Depth Well 11.89'

Borehole 16.05'

Formation of Completion Rocky Flats Alluvium

Casing Material Sch 5, type 316 TFJ stainless steel

Screen Material 0.010" wire wrap, type 316 TFJ stainless steel

Date Installed Aug. 6, 1987

Installed By J.B. Bergman
Geologist

Well No 19-87

Elevation Ground Surface 5967 98'

Top of Casing 5969 84'

Casing Diameter 2" ID

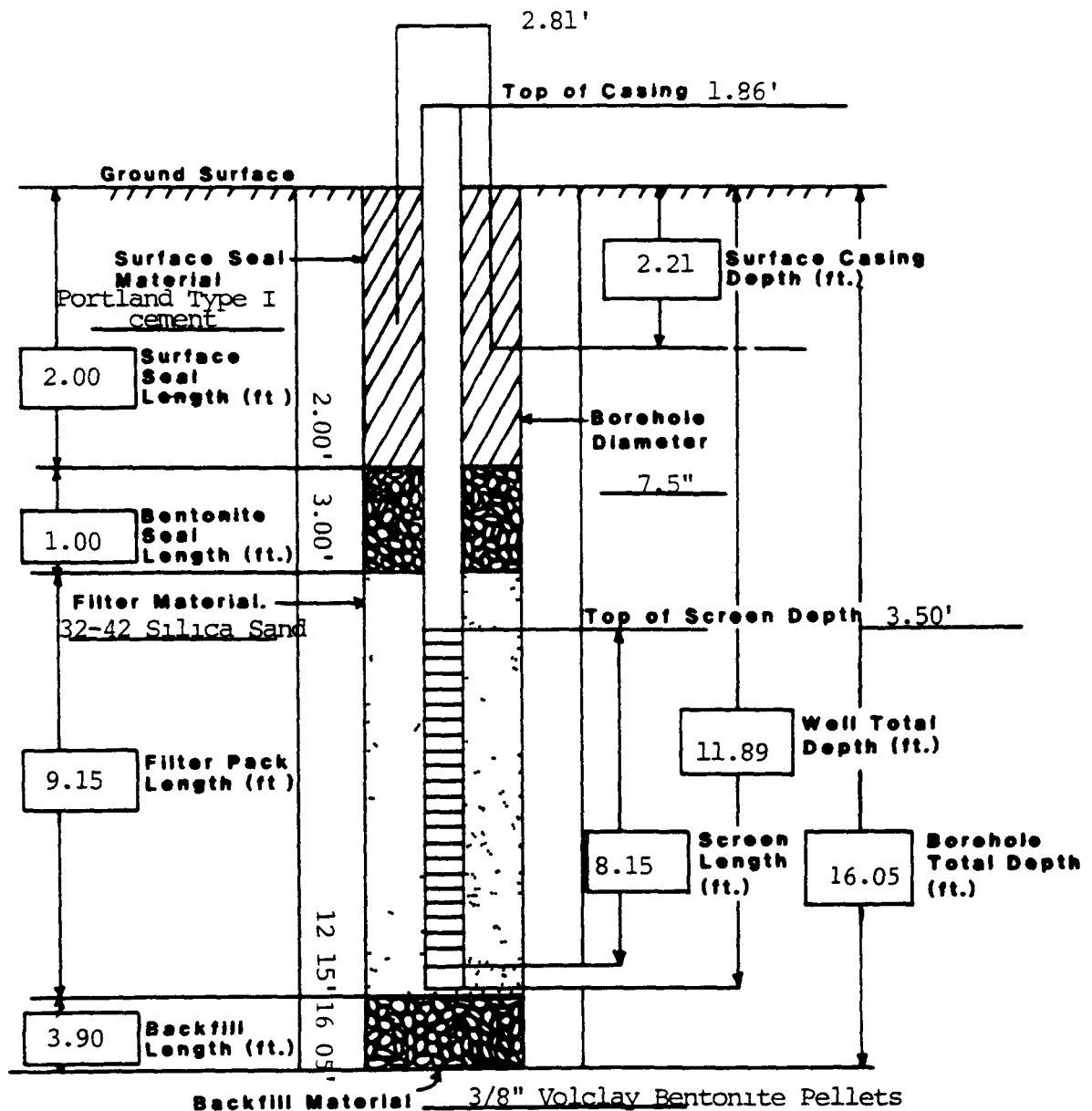
Surface Casing Diameter 5" ID

Approved By _____

Site Manager

CEARP Manager

Comments _____



INDEX OF DATA

Boring No 20-87BR

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant. Mound Area
Coordinates N 36644.48 E 23048.42
Total Depth 127.00'

Borehole/Well No 20-87BR
Ground Surface Elevation 5968 10'
Water Level Encountered None
Static 5861.19' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 30-31 and Aug. 3, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By J.B. Bergman; K.D. Hollaway
Geologist

Driller T. Merritt; P. Bushkovski
Helper T. High; J. Duncan; K. Parker
Drilling Fluid 0 - 51.70': None
51.70' - 127.0': Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 51.64' by J.B. Bergman on August 4, 1987.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ROCKY FLATS ALLUVIUM</u>	
			<u>0.0-2.0' SAMPLE.</u> Recovered 1 85/20' = 93% GRAVEL gray and pink quartzite in a moderate brown (5 YR 3/4) sand matrix, abundant roots and grasses in top 2", unconsolidated, unsorted, dry	HNu Background = 02-04, OVA Back- ground = 00, Ludlum Background = 00
5			<u>2.0-4.0' SAMPLE.</u> Recovered 20/20' = 100% SAND AND GRAVEL grayish orange (10 YR 7/4), ~30% clay, light brown (5 YR 5/6), abundant caliche, dry	
10			<u>4.0-6.4' SAMPLE.</u> Recovered 24/24' = 100% GRAVEL moderate yellowish brown (10 YR 5/4) matrix of clay, abundant caliche, unsorted, unconsolidated, angular, moist	
			<u>6.4-8.8' SAMPLE. LOST CORE</u> Drilled with center bit to get through boulders	
15			<u>8.8-10.8' SAMPLE.</u> Recovered 13/20' = 65% SAND AND GRAVEL moderate yellowish brown (10 YR 5/4) sand matrix with abundant quartzite pebbles and gravels, unconsolidated, unsorted, angular to sub-rounded, very fine-grained sand, moist	
20			<u>10.8-13.8' SAMPLE.</u> Recovered 35/30' = 117% 10.8-11.8' SAND AND GRAVEL same as above, moist	<u>18.8' Readings on</u> core HNu = 19.0 OVA = 12.0

LOG OF BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36644.48 E 23048.42
Total Depth 127 00'

Borehole/Well No 20-87BR
Ground Surface Elevation 5968.10'
Water Level Encountered None
Static 5861.19' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 30-31 and Aug. 3, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By J.B. Bergman; K.D. Hollaway
Geologist

Driller T. Merritt; P. Bushkovski
Helper T. High; J. Duncan; K. Parker
Drilling Fluid 0 - 51.70': None
51.70' - 127.0': Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 51.64' by J.B. Bergman on August 4, 1987.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			ARAPAHOE FORMATION	
			118-138' CLAYSTONE medium gray (N 5/0) with abundant moderate yellowish brown (10 YR 5/4) mottles, abundant black organic fragments, abundant caliche-reacts strongly with HCl, trace white very fine-grained sand, well sorted, moist	20.8-23.8' Readings on core HNu = 2.0 OVA = 0.0
25			<u>13.8-15.8' SAMPLE.</u> Recovered 2 0/2 0' = 100% SANDY CLAYSTONE moderate yellowish brown (10 YR 5/4), very fine-grained, light gray (N 6/0) sand and moderate yellowish brown (10 YR 5/4) sand, some caliche, some black organic fragments, well sorted, rounded, moist	23.8-25.8' Readings on core HNu = 15.0 OVA = 3.0
30			<u>15.8-18.8' SAMPLE.</u> Recovered 3 2/3 0' = 107% CLAYSTONE same as above, slightly moist	
			<u>18.8-20.8' SAMPLE.</u> Recovered 2 0/2 0' = 100% CLAYSTONE same as above, moist	34.70' Reading in well head HNU = 20-30, OVA = 9.0
35			<u>20.8-23.8' SAMPLE.</u> Recovered 3 0/3 0' = 100% CLAYSTONE olive gray (5 Y 3/2) with abundant moderate yellowish brown (10 YR 5/4) mottles, some organics, some caliche, trace light gray (N 6/0) sand, very fine-grained, rounded, moist	34.7-36.7' Readings on core HNu = 2.0 OVA = 18
40				

LOG OF BOREHOLE

Location Rocky Flats Plant. Mound Area
Coordinates N 36644.48 E 23048 42
Total Depth 127 00'

Borehole/Well No 20-87BR
Ground Surface Elevation 5968.10'
Water Level Encountered None
Static 5861.19' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 30-31 and Aug. 3, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By J.B. Bergman; K.D. Hollaway
Geologist

Driller T. Merritt; P. Bushkovski
Helper T. High; J. Duncan; K. Parker
Drilling Fluid 0 - 51.70': None
51.70' - 127.0': Water
Checked By _____
Site Manager

Comments Surface casing set to 51.64' by J.B. Bergman on August 4, 1987.
CEARP Manager

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
40			<u>23.8-25.8' SAMPLE.</u> Recovered 20/20' = 100% SANDY CLAYSTONE same as above with slight increase in sand content, moist	
			<u>25.8-28.8' SAMPLE</u> Recovered 30/30' = 100% SANDY CLAYSTONE same as above, moist	
45			<u>28.8-30.8' SAMPLE</u> Recovered 20/20' = 100% CLAYSTONE olive gray (5 Y 3/2) with abundant moderate yellowish brown (10 YR 5/4) mottles, abundant light brown (5 YR 5/6) FeO nodules, trace light gray (N 6/0) sandstone, very fine-grained, rounded, moist	
50			<u>30.8-33.8' SAMPLE.</u> Recovered 30/30' = 100% CLAYSTONE same as above, moist	No HNu, OVA, or Ludlum readings taken below 500'
			<u>33.8-34.7' SAMPLE.</u> No sample Adjust depth after taking a TD of borehole	<u>53.90-63.55' Packer</u> Test Interval #10
55			<u>34.7-36.7' SAMPLE</u> Recovered 20/20' = 100% CLAYSTONE olive gray (5 Y 3/2) with abundant light brown (5 YR 5/6) stains, wet at top 4"-probably slough, homoge- neous, dense, weathered, trace very fine- grained sand, dry	<u>55.90-65.55' Packer</u> Test Interval #9 <u>65.55-75.20' Packer</u> Test Interval #8
60				

LOG OF BOREHOLE

Location Rocky Flats Plant. Mound Area
Coordinates N 36644.48 E 23048.42
Total Depth 127.00'

Borehole/Well No 20-87BR
Ground Surface Elevation 5968.10'
Water Level Encountered None
Static 5861.19' (12/01/87)
Driller T. Merritt; P. Bushkovski
Helper T. High; J. Duncan; K. Parker
Drilling Fluid 0 - 51.70': None
51.70' - 127.0': Water
Checked By Site Manager

Drilling Company Boyles Bros
Date Drilled July 30-31 and Aug. 3, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By J.B. Bergman; K.D. Hollaway
Geologist

CEARP Manager

Comments Surface casing set to 51.64' by J.B. Bergman on August 4, 1987.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
60			<u>36.7-39.7' SAMPLE.</u> Recovered 3 5/2 0' = 88% CLAYSTONE olive gray (5 Y 3/2), some moderate yellowish brown (10 YR 5/4) stains, slightly weathered, homogenous, dense, abundant FeO nodules, some organic fragments, slightly moist	
65			<u>39.7-41.7' SAMPLE.</u> Recovered 2 1/2 0' = 105% CLAYSTONE same as above, slightly moist	
			<u>41.7-44.7' SAMPLE.</u> Recovered 1 7/3 0' = 85% CLAYSTONE same as above, dry	
70			<u>44.7-46.7' SAMPLE.</u> Recovered 2 0/2 0' = 100% CLAYSTONE olive gray (5 Y 3/2), some dark yellowish orange (10 YR 6/6) stains, friable, homogenous, some vertical fractures, dry	
			<u>46.7-49.7' SAMPLE.</u> Recovered 3 7/3 0' = 123% CLAYSTONE same as above, unweathered/weathered contact at 46 7', dry	<u>75.20-84.85' Packer Test Interval #7</u>
75			<u>49.7-51.7' SAMPLE.</u> Recovered 3 5/2 0' = 175% CLAYSTONE same as above, unweathered, dry	<u>77.20-86.85' Packer Test Interval #6</u>
80				

LOG OF BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36644.48 E 23048.42
Total Depth 127.00'

Borehole/Well No 20-87BR
Ground Surface Elevation 5968.10'
Water Level Encountered None
Static 5861.19' (12/01/87)
Driller T. Merritt; P. Bushkovski
Helper T. High; J. Duncan; K. Parker
Drilling Fluid 0 - 51.70': None
51.70' - 127.0': Water
Checked By _____
Site Manager

Drilling Company Boyles Bros
Date Drilled July 30-31 and Aug. 3, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By J.B. Bergman; K.D. Hollaway
Geologist

CEARP Manager

Comments Surface casing set to 51.64' by J.B. Bergman on August 4, 1987.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
80			<u>50.0-54.0' SAMPLE.</u> Recovered 20/40' = 50% RQD = 11/20' = 55% CLAYSTONE olive black (5 Y 2/1), un- weathered, damp	
85			<u>54.0-58.0' SAMPLE.</u> Recovered 50/40' = 125% RQD = 445/50' = 89% CLAYSTONE olive black (5 Y 2/1), some silt, unweathered, damp	<u>86.86-96.50' Packer</u> Test Interval #5
90			<u>58.0-62.0' SAMPLE.</u> Recovered 40/40' = 100% RQD = 400/40' = 100% 58.0-60.0' CLAYSTONE dark gray, some silt, some very fine-grained sand, damp 60.0-62.0' SANDY CLAYSTONE light gray, some clay, some silt, some very fine- grained sand, fairly well sorted, sub- rounded, trace fossils (plant stems and leaves), dry	
95			<u>62.0-66.0' SAMPLE.</u> Recovered 395/40' = 98.8% RQD = 270/395' = 68.35% SANDY CLAYSTONE olive black (5 Y 2/1), sand is 3.0-3.5 phi to very fine- grained, subrounded, some silt, some clay, trace fossils (plant stems and leaves), damp to dry	<u>96.50-106.15' Packer</u> Test Interval #4
100				

LOG OF BOREHOLE

Location Rocky Flats Plant: Mound Area
Coordinates N 36644.48 E 23048.42
Total Depth 127.00'

Borehole/Well No 20-87BR
Ground Surface Elevation 5968.10'
Water Level Encountered None
Static 5861.19' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 30-31 and Aug. 3, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By J.B. Bergman; K.D. Hollaway
Geologist

Driller T. Merritt; P. Bushkovski
Helper T. High; J. Duncan; K. Parker
Drilling Fluid 0 - 51.70': None
Checked By 51.70' - 127.0': Water
Site Manager

CEARP Manager

Comments Surface casing set to 51.64' by J.B. Bergman on August 4, 1987.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
100			<u>66.0-70.0' SAMPLE.</u> Recovered 3 7/4 0' = 92 5% RQD = 2 91/3 7' = 78 6% SANDY CLAYSTONE same as above, very light gray (N 8/0) to grayish black (N 2/0), presence of vertical lamination planes of sand, very fine-grained to 3'0- 3 5 phi, starting at 67 1', damp to dry	
105			<u>70.0-74.0' SAMPLE.</u> Recovered 5 2/4 0' = 130% RQD = 4 8/5 2' = 92 3% SANDY CLAYSTONE same as above, vertical lamination planes fade out at 70 5' but reappear at 71 6'-72 8', damp to dry	<u>106.15-115.80' Packer Test Interval #2</u>
110			<u>74.0-78.0' SAMPLE</u> Recovered 4 0/4 0' = 100% RQD = 3 0/4 0' = 60 5% SANDY CLAYSTONE same as above, damp to dry	<u>107.20-116.85' Packer Test Interval #3</u>
115			<u>78.0-79.5' SAMPLE.</u> Recovered 0 5/1 5' = 33 3% RQD = 0 5/0 5' = 100% SILTY CLAYSTONE dark gray (N 3/0) to light gray (N 7/0), some clay, some silt, some sand 3 5-2 5 phi to very fine- grained, mottled, indurated, dry	<u>114.42-124.07' Packer Test Interval #1</u>
120			<u>79.5-82.0' SAMPLE.</u> Recovered 3 5/2 5' = 140% RQD = 2 42/3 5' = 69 1% SILTY CLAYSTONE dark gray (N 3/0) to olive black (5 Y 2/1), some clay, some silt, some sand, occasional small seams of coal, damp	

LOG OF BOREHOLE

Location Rocky Flats Plant. Mound Area
Coordinates N 36644.48 E 23048.42
Total Depth 127.00'

Borehole/Well No 20-87BR
Ground Surface Elevation 5968.10'
Water Level Encountered None
Static 5861.19' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 30-31 and Aug. 3, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By J.B. Bergman; K.D. Hollaway
Geologist

Driller T. Merritt; P. Bushkovski
Helper T. High; J. Duncan; K. Parker
Drilling Fluid 0 - 51.70': None
51.70' - 127.0': Water
Checked By _____
Site Manager

Comments Surface casing set to 51.64' by J.B. Bergman on August 4, 1987.
CEARP Manager

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
120			<u>82.0-84.5' SAMPLE</u> Recovered $2\frac{15}{2}5' = 86\%$ RQD = $1\frac{48}{2}15 = 68.8\%$ SILTY CLAYSTONE same as above except less sand, damp	
125			<u>84.5-88.0' SAMPLE</u> Recovered $3\frac{1}{3}5' = 88.6\%$ RQD = $2\frac{68}{3}1' = 86.5\%$ SILTY CLAYSTONE same as above, except more sand in lenses, damp to dry	
			<u>88.0-92.0' SAMPLE</u> Recovered $4\frac{0}{4}0' = 100\%$ RQD = $3\frac{76}{4}0' = 94\%$ SILTY CLAYSTONE same as above, damp	
130			<u>92.0-96.0' SAMPLE</u> Recovered $1\frac{65}{4}0' = 41.25\%$ RQD = $1\frac{65}{1}65' = 100\%$ SILTY CLAYSTONE same as above, dry	
			<u>96.0-99.0' SAMPLE</u> Recovered $3\frac{4}{3}0' = 113\%$ RQD = $2\frac{5}{3}4' = 73.5\%$ SILTY CLAYSTONE same as above, dry	
			<u>99.0-102.0' SAMPLE</u> Recovered $2\frac{7}{3}0' = 90\%$ RQD = $1\frac{38}{2}7' = 53\%$ SILTY CLAYSTONE same as above, dry	

LOG OF BOREHOLE

Location Rocky Flats Plant. Mound Area
Coordinates N 36644.48 E 23048.42
Total Depth 127.00'

Borehole/Well No 20-87BR
Ground Surface Elevation 5968.10'
Water Level Encountered None
Static 5861.19' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 30-31 and Aug. 3, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By J.B. Bergman; K.D. Hollaway
Geologist

Driller T. Verritt, P. Bushkovski
Helper T. High, J. Duncan; K. Parker
Drilling Fluid 0 - 51.70': None
51.70' - 127.0': Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 51.64' by J.B. Bergman on August 4, 1987.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>102.0-105.0' SAMPLE.</u> Recovered 50/30' = 167% RQD = 38/50' = 76% SILTY CLAYSTONE greenish black (5 GY 2/1), some clay, some silt, some sand lenses, thin sand lamination, recovered 20' of silty clay core from previous run, dry	
			<u>105.0-109.0' SAMPLE</u> Recovered 40/40' = 100% RQD = 40/40' = 100% 105-107.25' CLAYSTONE, SANDSTONE AND SILTSTONE same as above, dry 107.25'-109.0' CLAYEY SANDSTONE olive black (5 Y 2/1), sand well sorted, subangular, 2.5-1.5 phi, clay in pockets, more prominent 108.75-109.0, moist	
			<u>109.0-113.0' SAMPLE.</u> Recovered 40/40' = 100% RQD = 40/40' = 100% CLAYEY SANDSTONE same as above, except finer grained 3.0-3.5 phi, well ce- mented, damp	
			<u>113.0-117.0' SAMPLE</u> Recovered 40/40' = 100% RQD = 40/40' = 100% 113.0-115.8' CLAYEY SANDSTONE light gray (N 7/0), sand 3.0-3.5 phi, subangular, well cemented, moist 115.8-117.0' SANDY CLAYSTONE medium gray (5 N/0), some clay, some sand, some silt, blocky, moist	

LOG OF BOREHOLE

Location Rocky Flats Plant. Mound Area
Coordinates N 36644.48 E 23048.42
Total Depth 127 00'

Borehole/Well No 20-87BR
Ground Surface Elevation 5968.10'
Water Level Encountered None
Static 5861.19' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 30-31 and Aug. 3, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By J.B. Bergman; K.D. Hollaway
Geologist

Driller T. Merritt; P. Bushkovski
Helper T. High; J. Duncan; K. Parker
Drilling Fluid 0 - 51.70': None
Checked By 51.70' - 127.0': Water
Site Manager

CEARP Manager

Comments Surface casing set to 51.64' by J.B. Bergman on August 4, 1987.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>117.0-121.0' SAMPLE.</u> Recovered 3 6/4 0' = 90% RQD = 2 5/3 6' = 77 7% 117-118 5' CLAYSTONE medium gray (5 N/0), blocky, moderately cemented, moist 118 5-119 5' CLAYEY SANDSTONE light gray (N 7/0), moderate cementation, slightly moist 119 5-121 0' CLAYSTONE medium gray (5 N/0), sand fine-grained, moist	
			<u>121.0-125.0' SAMPLE.</u> Recovered 1 5/4 0' = 37 5% RQD = 1 2/1 5' = 80% CLAYSTONE same as above, massive, moist	
			<u>125.0-127 0' SAMPLE</u> Recovered 3 8/2 0' = 190% RQD = 2 5/3 8' = 66% CLAYSTONE same as above, recovered 1 8' of claystone, same description from previous core run, moist	
			TOTAL DEPTH 127 00'	

WELL
COMPLETION
INFORMATION

Location Rocky Flats Plant; Mound Area

Coordinates N 36644.48 E 23048.42

Total Depth Well 116.36'

Borehole 126.20'

Formation of Completion Arapahoe Formation

Casing Material Sch 5, type 316 TFJ stainless steel

Screen Material 0.010" wire wrap, type 316 TFJ stainless steel

Date Installed Aug 12, 1987

Installed By K.D. Hollway
Geologist

Well No 20-87BR

Elevation Ground Surface 5968.10'

Top of Casing 5970.10'

Casing Diameter 2" ID

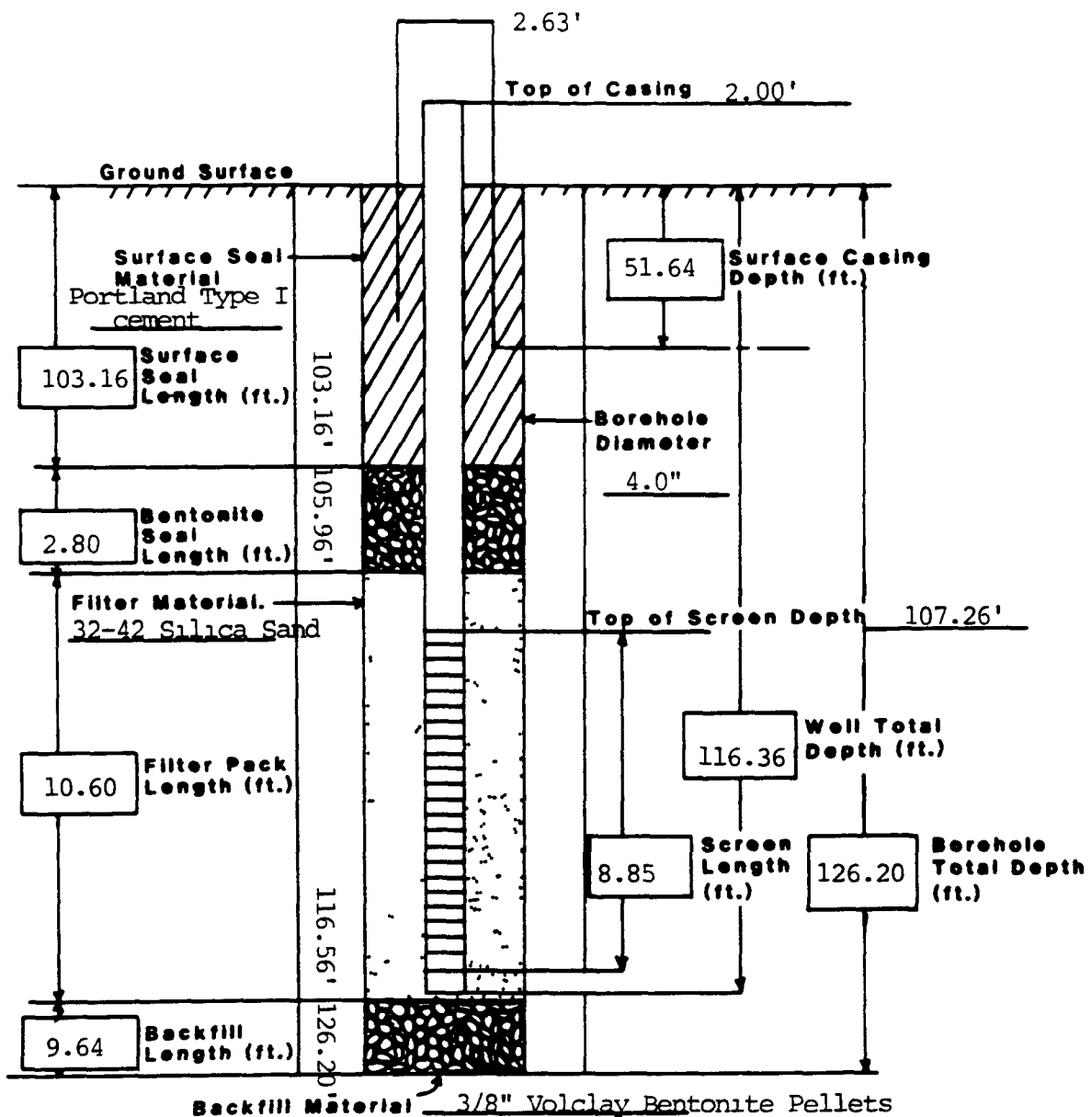
Surface Casing Diameter 5" ID

Approved By _____

Site Manager

CEARP Manager

Comments Surface casing set to 51.64' by J.B. Bergman on August 4, 1987



INDEX OF DATA

Boring No 21-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

LOG OF BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36980.21 E 22693.84
Total Depth 17.00'

Borehole/Well No 21-87
Ground Surface Elevation 5927.58'
Water Level Encountered 7.0'
Static Dry

Drilling Company Boyles Bros
Date Drilled October 16, 1987
Drilling Method Hollow Stem Auger
Logged By K. D. Hollaway
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>COLLUVIUM</u>	
			<u>0.0-2.0' SAMPLE.</u> Recovered 1 9/20' = 95% SANDY CLAY dark yellowish brown (10 YR 4/2) to dusky yellowish brown (10 YR 2/2), quartzite cobbles, broken to subangular, sand very fine-grained, poorly sorted, unconsolidated, grass and roots to 0.2', reactive to HCl, damp	HNu Background=13 OVA Background=28 Alpha Background = 01
5			<u>2.0-4.0' SAMPLE</u> Recovered 1 0/20' = 50% SANDY CLAY same as above, damp	<u>0.0-2.0'</u> Readings on core HNu = 70, OVA = 32
			<u>4.0-7.0' SAMPLE.</u> Recovered 0 3/30' = 10% CLAY light olive gray (5 Y 5/2), broken quartzite cobbles, trace very fine-grained sand, unconsolidated, damp	<u>2.0-4.0'</u> Readings on core HNu = 200, OVA = 36
10			<u>7.0-9.5' SAMPLE.</u> Recovered 2 5/25' = 100% 7 0-8 8' CLAY light olive gray (5 Y 5/2), occasional subrounded quartzite pebbles, trace very fine-grained sand, some iron nodules, damp to moist 8 8-9 5' SANDY CLAY dusky yellowish brown (10 YR 2/2), very fine-grained sand, some organics, moist to wet	<u>7.0-9.5'</u> Readings on core HNu = 50, OVA = 38
15				
20				

LOG
OF
BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36980.21 E 22693.84
Total Depth 17 00'

Drilling Company Boyles Bros
Date Drilled October 16, 1987
Drilling Method Hollow Stem Auger
Logged By K. D. Hollaway
Geologist

Borehole/Well No 21-87
Ground Surface Elevation 5927 58'
Water Level Encountered 7.0'
Static Dry
Driller R. Sharp
Helper T. Merritt
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>9.5-12.0' SAMPLE.</u> Recovered 2 5/2 5' = 100% 9.5-10.4' SANDY CLAY light olive gray (5 Y 5/2), occasional subrounded to rounded quartzite pebbles, very fine- grained sand, trace caliche, damp to moist	
			<u>ARAPAHOE FORMATION</u>	
			10.4-12.0' SANDY CLAYSTONE light olive gray (5 Y 5/2) to medium gray (N 5/0) with dark yellowish orange (10 YR 6/6) iron staining, very fine-grained sand, trace caliche, damp to moist	
			<u>12.0-14.5' SAMPLE.</u> Recovered 2 5/2 5' = 100% CLAYSTONE same as above, damp to moist	
			<u>14.5-17.0' SAMPLE.</u> Recovered 2 3/2 5' = 92% CLAYSTONE olive gray (5 Y 4/1) with trace dark yellowish orange (10 YR 6/6) iron staining, some very fine-grained sand more than above, trace caliche, damp to moist	
			TOTAL DEPTH 17 00'	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant; Mound Area
 Coordinates N 36980.21 E 22693.84
 Total Depth Well 10.555'
 Borehole 17 00'

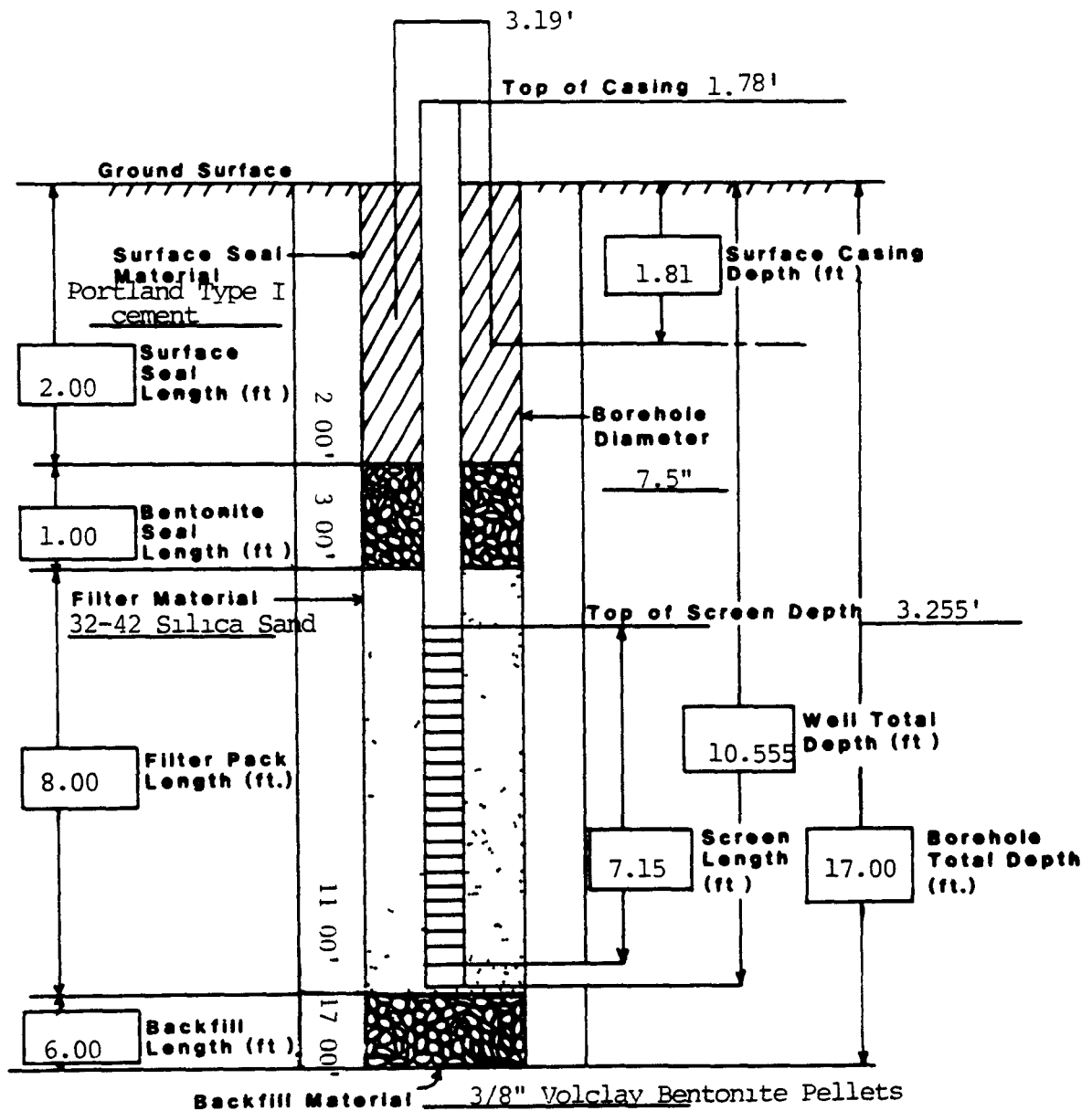
Well No 21-87
 Elevation Ground Surface 5927.58'
 Top of Casing 5929.36'

Formation of Completion Rocky Flats Alluvium
 Casing Material Sch 5, type 316 TFJ stainless steel
 Screen Material 0.010" wire wrap, type 316 TFJ stainless steel
 Date Installed Oct 16, 1987
 Installed By K. D. Holliday
 Geologist

Casing Diameter 2" ID
 Surface Casing Diameter 5" ID
 Approved By _____
 Site Manager

 CEARP Manager

Comments _____



INDEX OF DATA

Boring No 22-87BR

Completed as well? Yes

Data in File

- X Log of Borehole
- X Well Construction Summaries
- Well Development Summaries
- Hydraulic Conductivity Test Data
and Results
- Packer Test Data and Results
- Water Level Data
- Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36934.99 E 22715 72
Total Depth 110 40'

Borehole/Well No 22-87BR
Ground Surface Elevation 5930.70'
Water Level Encountered 12.2'
Static 5852.04' (12/01/87)

Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Hollaway; J.B. Beroman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Hollaway on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>COLLUVIUM</u>	
			<u>0.0-2.0' SAMPLE.</u> Recovered 2 0/2 0' = 100% CLAYEY SAND moderate yellowish brown (10 YR 4/2) to dusky yellowish brown (10 YR 2/2), subrounded to subangular quartzite cobbles and pebbles, sand fine-grained to coarse-grained, poorly sorted, calcareous, unconsolidated, some caliche, dry	HNu Background=0 6 OVA Background=1 2 <u>0-2.0' Readings on</u> core HNu = 1 0, OVA = 4 0
5			<u>2.0-4.0' SAMPLE</u> Recovered 1 5/2 0' = 75% CLAYEY SAND same as above, dry	<u>2.0-4.0' Readings on</u> core HNu = 4 0, OVA = 1 2
10			<u>4.0-6.0' SAMPLE</u> Recovered 2 0/2 0' = 100% CLAY light olive gray (5 Y 5/2) to dusky yellowish brown (10 YR 2/2), trace subrounded quartzite cobbles, trace very fine-grained sand, trace caliche, damp	<u>4.0-6.0' Readings on</u> core HNu = Background, OVA = 1 6
15			<u>6.0-8.0' SAMPLE</u> Recovered 2 0/2 0' = 100% CLAY same as above except with dark yellowish orange (10 YR 6/6) iron staining and stringers of brownish gray (5 YR 4/1) claystone, damp	<u>6.0-8.0' Readings on</u> core HNu = 1 2, OVA = 1 0
20			<u>8.0-10.2' SAMPLE</u> Recovered 2 2/2 2' = 100% CLAY light olive brown (5 Y 5/6) to light olive gray (5 Y 5/2), some iron staining, some sand, trace caliche, damp	<u>8.0' Readings in</u> augers OVA = 100 0, HNu = 1 2 <u>8.0-10.2' Readings in</u> core HNu = Back- ground, OVA = 2 0 <u>10.2-12.2' Readings</u> on core HNu = 2 0, OVA = 2 0

LOG OF BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36934.99 E 22715.72
Total Depth 110.40'

Borehole/Well No 22-87BR
Ground Surface Elevation 5930.70'
Water Level Encountered 12.2'
Static 5852.04' (12/01/87)

Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Holliday, J.B. Beroman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Holliday on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>10.2-12.2' SAMPLE.</u> Recovered 20/20' = 100% CLAY light olive gray (5 Y 5/2), some very fine-grained sand stained dark yellowish orange (10 YR 6/6), subrounded quartzite cobbles, some iron staining, trace caliche, damp	<u>12.2-26.5'</u> No readings above background on the core
25			<u>12.2-14.2' SAMPLE.</u> Recovered 20/20' = 100% 12.2-12.8' SANDY CLAY same as above, moist to wet	<u>26.5-27.5'</u> Readings on core HNu = Back- ground, OVA = 16
			<u>ARAPAHOE FORMATION</u>	
30			12.8-14.2' SANDY CLAYSTONE same as above except no quartzite cobbles, moist to wet	<u>28.5-29.5'</u> Readings on core HNu = 20, OVA = 10
			<u>14.2-16.2' SAMPLE.</u> Recovered 20/20' = 100% CLAYSTONE light olive gray (5 Y 5/2), some very fine-grained sand, some dusky yellow (5 Y 6/4), trace caliche, damp to moist	
35			<u>16.2-18.2' SAMPLE</u> Recovered 20/20' = 100% CLAYSTONE olive gray (5 Y 4/1), occa- sional dark yellowish orange (10 YR 6/6) iron staining, trace very fine-grained sand, trace caliche, damp	
			<u>18.2-20.2' SAMPLE.</u> Recovered 20/20' = 100% CLAYSTONE same as above, damp	
40				

LOG OF BOREHOLE

Location Rocky Flats Plant, Mound Area
Coordinates N 36934.99 E 22715.72
Total Depth 110 40'

Borehole/Well No 22-87BR
Ground Surface Elevation 5930 70'
Water Level Encountered 12.2'
Static 5852.04' (12/01/87)

Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Hollaway; J.B. Beraman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Hollaway on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
40			<u>20.2-22.2' SAMPLE.</u> Recovered 2 0/2 0' = 100% CLAYSTONE same as above, damp Hole readjusted to 22 50'	
45			<u>22.5-23.5' SAMPLE.</u> Recovered 1 5/1 0' = 150% CLAYSTONE same as above except light olive gray (5 Y 5/2) with trace dark yel- lowish orange (10 YR 6/6) iron staining, no caliche, dry	<u>45.60-52.55' Packer</u> Test Interval #7
50			<u>23.5-24.5' SAMPLE.</u> Recovered 1 0/1 0' = 100% CLAYSTONE same as above except no iron staining, homogenous, dry to slightly damp	
			<u>24.5-25.5' SAMPLE.</u> Recovered 1 4/1 0' = 140% CLAYSTONE same as above, dry to slightly damp	<u>52.55-62.20' Packer</u> Test Interval #6
55			<u>25.5-26.5' SAMPLE.</u> Recovered 1 4/1 0' = 140% CLAYSTONE light olive gray (5 Y 5/2) with trace dark yellowish orange (10 YR 6/6) iron staining in small fractures, trace very fine-grained sand, trace silt, damp to dry	
			<u>26.5-27.5' SAMPLE.</u> Recovered 1 2/1 0' = 120% CLAYSTONE same as above, damp	
60				

LOG OF BOREHOLE

Location Rocky Flats Plant, Mound Area
Coordinates N 36934.99 E 22715 72
Total Depth 110.40'

Borehole/Well No 22-87BR
Ground Surface Elevation 5930.70'
Water Level Encountered 12.2'
Static 5852.04' (12/01/87)

Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Hollaway, J.B. Bergman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Hollaway on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
60			<u>27.5-28.5' SAMPLE.</u> Recovered 15/10' = 150% CLAYSTONE same as above, damp to moist	<u>62.20-71.85' Packer</u> Test Interval #5
			<u>28.5-29.5' SAMPLE.</u> Recovered 15/10' = 150% CLAYSTONE same as above except more iron staining, damp	
65			<u>29.5-30.5' SAMPLE.</u> Recovered 15/10' = 150% CLAYSTONE same as above, trace organics, damp	
			<u>30.5-31.5' SAMPLE.</u> Recovered 15/10' = 150% SANDY CLAYSTONE light olive gray (5 Y 5/2) with dark yellowish orange (10 YR 6/6) iron staining and grayish orange (10 YR 7/4) very fine-grained interbedded sands, occasional limonite nodules, some silt, some organics, dry	<u>71.85-81.50' Packer</u> Test Interval #4
70			<u>31.5-32.5' SAMPLE</u> Recovered 10/10' = 100% SANDY CLAYSTONE olive black (5 Y 2/1) to light olive gray (5 Y 5/2), limonite nodules and iron staining moderate brown (5 YR 4/4), very fine-grained interbedded sands, grayish orange (10 YR 7/4), some silt, trace organics, dry	
75				
80				

LOG OF BOREHOLE

Location Rocky Flats Plant, Mound Area
Coordinates N 36934.99 E 22715.72
Total Depth 110.40'

Borehole/Well No 22-87BR
Ground Surface Elevation 5930.70'
Water Level Encountered 12.2'
Static 5852.04' (12/01/87)

Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Hollaway; J.B. Bergman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Hollaway on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
80			<u>32.5-33.5' SAMPLE.</u> Recovered 12/10' = 120% CLAYSTONE same as above except no interbedded sands, no nodules, less sand, dry	<u>81.50-91.15' Packer</u> <u>Test Interval #3</u>
			<u>33.5-34.5' SAMPLE.</u> Recovered 15/10' = 150% CLAYSTONE light olive gray (5 Y 5/2) to olive black (5 Y 2/1) with some mod- erate yellowish brown iron staining (10 YR 5/4), some very fine-grained sand, some silt, some organics, brittle, dry	<u>82.70-92.35' Packer</u> <u>Test Interval #2</u>
85			<u>34.5-35.5' SAMPLE</u> Recovered 10/10' = 100% CLAYSTONE same as above, dry	
			<u>35.5-36.5' SAMPLE.</u> Recovered 15/10' = 150% CLAYSTONE olive black (5 Y 2/1) to grayish black (N 2/0), some very fine- grained sand, some silt, some organics, trace limonite nodules, dry Weathered/ unweathered contact = 360'	<u>92.35-102.0' Packer</u> <u>Test Interval #1</u>
90			<u>36.5-37.5' SAMPLE.</u> Recovered 20/10' = 200% CLAYSTONE olive black (5 Y 2/1), some very fine-grained sand in fractures with dark yellowish orange (10 YR 6/6) iron staining, some organics, dry to slightly damp	
95				
100				

LOG OF BOREHOLE

Location Rocky Flats Plant, Mound Area
Coordinates N 36934.99 E 22715.72
Total Depth 110.40'

Borehole/Well No 22-87BR
Ground Surface Elevation 5930.70'
Water Level Encountered 12.2'
Static 5852.04' (12/01/87)

Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Holliway, J.B. Beroman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Holliway on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
100			<u>37.5-38.5' SAMPLE.</u> Recovered 10/10' = 100% CLAYSTONE same as above with more sands, dry	
105			<u>38.5-39.5' SAMPLE.</u> Recovered 1.3/10' = 130% CLAYSTONE olive black (5 Y 2/1) to dark gray (N 3/0), some very fine-grained sand with moderate yellowish brown (10 YR 5/4) staining, some silt, some organ- ics, dry	
110			<u>39.5-40.5' SAMPLE.</u> Recovered 12/10' = 120% CLAYSTONE same as above with less sands and less iron staining, dry	
115			<u>40.5-41.5' SAMPLE.</u> Recovered 12/10' = 120% CLAYSTONE olive black (5 Y 2/1) to dark gray (N 3/0), very fine-grained cal- careous sand in fractures with moderate yellowish brown (10 YR 5/4) staining, at 41.2' band of caliche (or calcareous sand) reacts strongly with HCl, some organics, dry	
			<u>41.5-42.5' SAMPLE.</u> Recovered 15/10' = 150% CLAYSTONE same as above, dry	
			<u>42.5-43.5' SAMPLE.</u> Recovered 14/10' = 140% CLAYSTONE same as above, dry	

LOG OF BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36934.99 E 22715.72
Total Depth 110.40'

Borehole/Well No 22-87BR
Ground Surface Elevation 5930.70'
Water Level Encountered 12.2'
Static 5852.04' (12/01/87)

Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Holliway, J.B. Bergman
Geologist

Driller R. Sharo
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Holliway on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>45.1-49.50' SAMPLE.</u> Recovered 3 7/4 5' = 82% RQD = 2 6/3 7' = 70% 45.1-45.6' CLAYSTONE dark greenish gray (5 GY 4/1), dense, very broken, probably slough 45.6-47.4' SANDSTONE dark greenish gray (5 GY 4/1), fine-grained, well sorted, some moderate brown (5 YR 4/4) iron stains, trace organics, fracture (~80°) at 46.5-46.7' filled with iron stains, moist 47.4-49.5' CLAYSTONE dark greenish gray (5 GY 4/1), dense, no stains, homogenous, dry to moist	
			<u>49.5-52.5' SAMPLE.</u> Recovered 2 7/3 0' = 90% RQD = 1 2/2 7' = 44% CLAYSTONE olive gray (5 Y 3/2), no silt, no sand, homogenous, trace organic fragments, consolidated, moist	
			<u>52.5-56.5' SAMPLE.</u> Recovered 3 9/4 0' = 98% RQD = 3 9/3 9' = 100% CLAYSTONE same as above, moist	
			<u>56.5-60.5' SAMPLE.</u> Recovered 3 8/4 0' = 95% RQD = 1 3/3 8' = 34% CLAYSTONE dark gray (N 3/0) to grayish black (N 2/0), dense, homogenous, some carbonaceous debris, moist to wet	

LOG OF BOREHOLE

Location Rocky Flats Plant, Mound Area
Coordinates N 36934.99 E 22715.72
Total Depth 110.40'

Borehole, Well No 22-87BR
Ground Surface Elevation 5930.70'
Water Level Encountered 12.2'
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Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Hollaway; J.B. Beroman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Hollaway on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>60.5-64.5' SAMPLE.</u> Recovered 3 6/4 0' = 90% RQD = 3 6/3 6' = 100% CLAYSTONE dark gray (N 3/0), dense, consolidated, homogenous, some carbonaceous debris, sandy from 60 9-61 4', moist to wet	
			<u>64.5-68.5' SAMPLE.</u> Recovered 3 3/4 0' = 83% RQD = 2 1/3 3' = 64% 64 5-66 6' CLAYSTONE same as above 66 6-67 8' MUDSTONE brownish gray (5 YR 4/1), very fine-grained, "sulphur-like" smell when HCl is added, abundant carbonaceous fragments, fragments strongly react with HCl, cement only slightly reacts when powdered, very hard and dense, dry	
			<u>68.5-72.5' SAMPLE.</u> Recovered 4 0/4 0' = 100% RQD = 3 7/4 0' = 93% CLAYSTONE brownish black (5 YR 2/1), trace very fine-grained sand, abundant organic fragments, moist to wet	
			<u>72.5-76.5' SAMPLE.</u> Recovered 3 7/4 0' = 93% RQD = 3 7/3 7' = 100% CLAYSTONE same as above, no sand, fractures at 76 0' and 76 3' (~45°), moist to wet	

LOG
OF
BOREHOLE

Location Rocky Flats Plant, Mound Area
Coordinates N 36934 99 E 22715.72
Total Depth 110.40'

Borehole/Well No 22-87BR
Ground Surface Elevation 5930.70'
Water Level Encountered 12.2'
Static 5852.04' (12/01/87)

Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Hollaway, J.B. Beroman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Hollaway on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>76.5-80.5' SAMPLE.</u> Recovered 4 0/4 0' = 100% RQD = 3 6/4 0' = 90% CLAYSTONE same as above TOTAL DEPTH OF HOLE 78 50', AD- JUST DEPTH <u>78.5-82.5' SAMPLE.</u> Recovered 3 7/4 0' = 93% RQD = 3 7/3 7' = 100% 78 5-81 5' CLAYSTONE same as above 81 5-82 5' SANDSTONE medium gray (N 5/0), well sorted, fine to very fine- grained, rounded, some silt, some organ- ics, consolidated, homogenous, moist <u>82.5-86.5' SAMPLE.</u> Recovered 4 0/4 0' = 100% RQD = 3 0/4 0' = 75% SANDSTONE medium gray (N 5/0), fine to medium-grained, rounded, well sorted, consolidated, calcareous cementation from 86 3-86 5'-strongly reacts with HCl, some clay layers <1" thick present throughout, wet to moist	

LOG OF BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36934 99 E 22715.72
Total Depth 110.40'

Borehole Well No 22-87BR
Ground Surface Elevation 5930.70'
Water Level Encountered 12.2'
Static 5852.04' (12/01/87)

Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Hollaway, J.B. Bergman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Hollaway on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>86.5-90.5' SAMPLE.</u> Recovered 2 6/4 0' = 65% RQD = 1 3/2 6' = 50% 86.5-87.1' SANDSTONE medium light gray (N 6/0), fine to medium-grained, rounded, well sorted, calcareous cement, very dense and consolidated, dry 87.1-88.5' INTERBEDDED SANDSTONE AND CLAYSTONE sandstone layers medium gray (N 5/0), 0.5" to 2" thick, claystone layers medium dark gray (N 4/0), consolidated, moist 88.5-89.1' CLAYSTONE medium dark gray (N 4/0) with some very thin (<0.5') sandstone layers, same sand as above, moist	
			<u>90.5-95.0' SAMPLE.</u> Recovered 4 0/4 5' = 89% RQD = 3 3/4 0' = 83% INTERBEDDED SANDSTONE/ CLAYSTONE medium light gray (N 6/0) sandstone and medium dark gray (N 4/0) claystone, sandstone layers 0.5 to 1' thick, claystone layers 0.2-0.5' thick, decrease sandstone content with depth, crossbedded sands, moist to wet	

LOG OF BOREHOLE

Location Rocky Flats Plant; Mound Area
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Total Depth 110.40'

Borehole, Well No 22-87BR
Ground Surface Elevation 5930.70'
Water Level Encountered 12.2'
Static 5852.04' (12/01/87)

Drilling Company Boyles Bros
Date Drilled Sept 30 & Oct 7-8, 1987
Drilling Method Hollow Stem Auger; Rotary Core
Logged By K.D. Holliway; J.B. Bergman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid 0.0 - 45.1' None;
45.1' - 110.4' Water
Checked By _____
Site Manager

CEARP Manager

Comments Surface casing set to 43.59' by K.D. Holliway on October 2, 1987

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>95.0-99.0' SAMPLE</u> Recovered 40/40' = 100% RQD = 28/40' = 70% INTERBEDDED SANDSTONE/ CLAY- STONE same as above with claystone layer from 97.3-98.7', moist to wet	
			<u>99.0-103.0' SAMPLE</u> Recovered 20/40' = 50% RQD = 13/20' = 65% INTERBEDDED SANDSTONE/ CLAY- STONE same as above with less sand content, layers are not distinct gradual changes, moist to wet	
			<u>102.0-107.0' SAMPLE</u> Recovered 50/50' = 100% RQD = 50/50' = 100% CLAYSTONE medium dark gray (N 4/0), trace silt, trace carbonaceous fragments, homogenous, consolidated, dense, moist (picked up one foot of core from last run)	
			<u>107.0-111.0' SAMPLE</u> Recovered 20/40' = 50% RQD = 00/20' = 0% CLAYSTONE same as above, very bro- ken, moist	
			TOTAL DEPTH 110.40'	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant; Mound Area

Coordinates N 36934 99 E 22715.72

Total Depth Well 88.70'

Borehole 110.40'

Well No 22-87BR

Elevation Ground Surface 5930.70'

Top of Casing 5932.49'

Formation of Completion Arapahoe Formation

Casing Material Sch 5, type 316 TFJ stainless steel

Casing Diameter 2" ID

Screen Material 0.010" wire wrap, type 316 TFJ stainless steel

Surface Casing Diameter 5" ID

Date Installed Oct. 10, 1987

Approved By _____

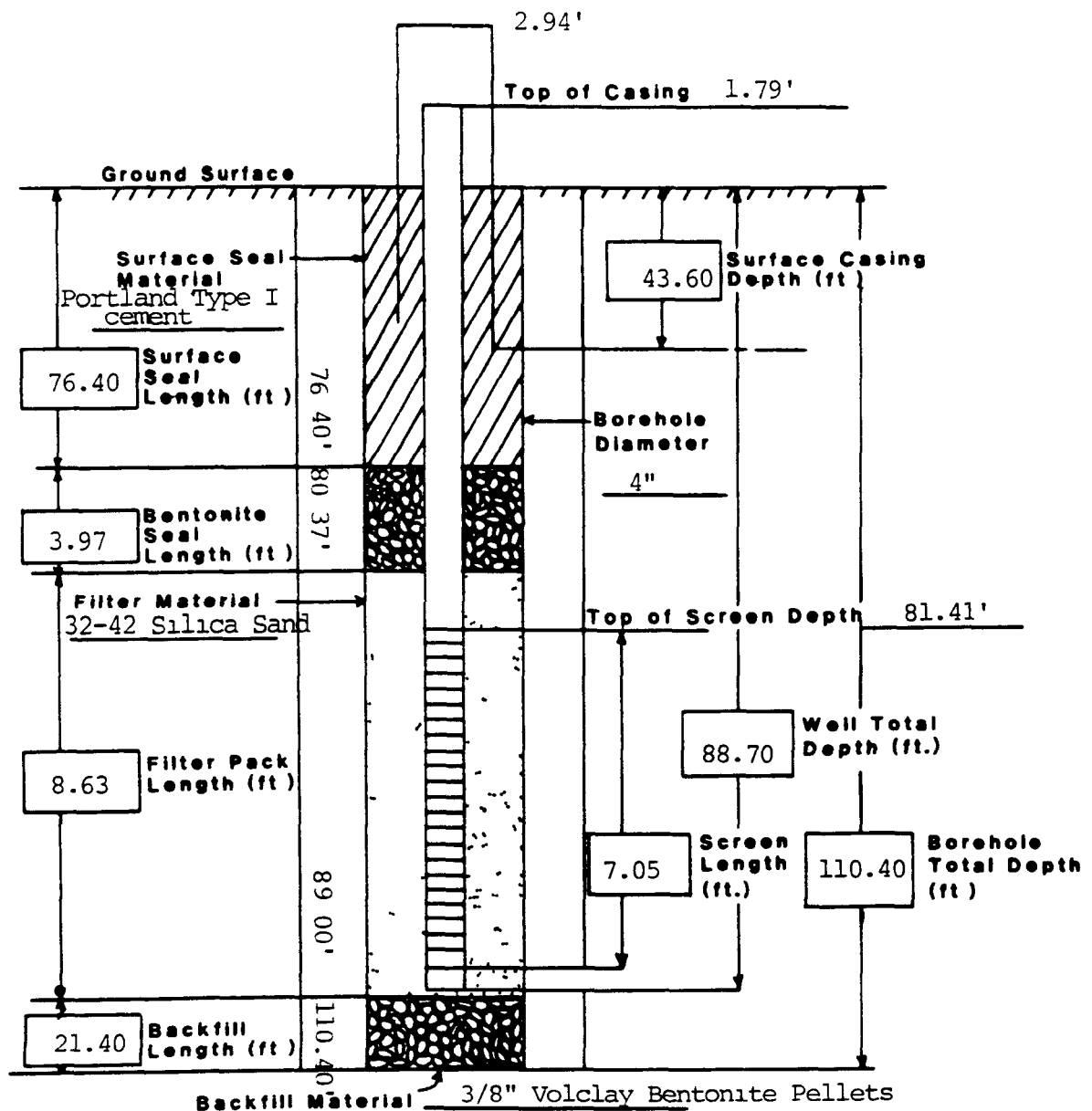
Installed By K. D. Hollaway

Site Manager

Geologist

CEARP Manager

Comments Surface casing set to 43.60' by K. D. Hollaway October 9, 1987



INDEX OF DATA

Boring No 23-87BR

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Mound Area
Coordinates N 36415.15 E 22802.78
Total Depth 45.30'

Borehole/Well No 23-87BR
Ground Surface Elevation 5972.34'
Water Level Encountered 19.0'
Static 5958.39' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 17-21, 1987
Drilling Method Hollow Stem Auger
Logged By S. Rogal; K.D. Holliday
Geologist

Driller D. Jarvie
Helper J. Duncan
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			ROCKY FLATS ALLUVIUM	
			<u>0.0-2.0' SAMPLE.</u> Recovered 1 5/20' = 75% 0-1 0' SAND dusky brown (5 YR 2/2), fine-grained, some grass, dry 1 0-1 5' SILTY SAND dusky yellow (5 Y 6/4), some gravel, dry	HNu Background=20 OVA Background=30 Ludlum Background = 00 <u>0-2.0'</u> No readings over background on core
5			<u>2.0-4.0' SAMPLE.</u> Recovered 1 4/20' = 70% SAND dusky yellow (5 Y 6/4), fine- grained, some gravel and cobbles, iron discoloration, dry	<u>2.0-4.0'</u> Readings on core HNu = 30, OVA = 50
10			<u>4.0-5.0' SAMPLE.</u> Recovered 0 9/10' = 90% GRAVEL AND SAND same as above, dry	<u>4.0-5.0'</u> Readings on core HNu = 50, OVA = 70
			<u>5.0-7.0' SAMPLE.</u> Recovered 0 4/20' = 20% GRAVEL AND SAND light olive brown (5 Y 5/6), trace silt, dry	<u>5.0-7.0'</u> Readings on core HNu = 50, OVA = 60
15			<u>7.0-9.0' SAMPLE.</u> Recovered 1 7/20' = 85% GRAVEL AND SAND same as above, dry	<u>7.0-9.0'</u> Readings on core HNu = 20, OVA = 50
			<u>9.0-11.0' SAMPLE.</u> Recovered 0 6/20' = 30% GRAVEL AND SAND same as above, dry	<u>9.0-11.0'</u> No readings over background on core
20				

LOG OF BOREHOLE

Location Rocky Flats Plant: Mound Area
Coordinates N 36415.15 E 22802.78
Total Depth 45.30'

Borehole/Well No 23-87BR
Ground Surface Elevation 5972.34'
Water Level Encountered 19.0'
Static 5958.39' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 17-21, 1987
Drilling Method Hollow Stem Auger
Logged By S. Rogal; K.D. Hollaway
Geologist

Driller D. Jarvie
Helper J. Duncan
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>11.0-13.0' SAMPLE.</u> Recovered 0 43/20 = 20% GRAVEL AND SILT moderate reddish brown (10 R 4/6), trace fine-grained sand, cobble stuck in shoe of barrel, damp	<u>11.0-13.0' Readings</u> on core HNu = 50, OVA = 40
			<u>13.0-15.0' SAMPLE.</u> Recovered 1 7/20' = 85% GRAVEL AND SILT same as above with iron and limonite staining, damp	<u>13.0-15.0' Readings</u> on core HNu = 30, OVA = 50
25			<u>15.0-17.0' SAMPLE</u> Recovered 1 98/20' = 99% 15.0-15.25' GRAVEL AND SILT same as above, damp	<u>15.0-17.0' Readings</u> on core HNu = 20, OVA = 50
			<u>ARAPAHOE FORMATION</u>	<u>17.0-19.0' Readings</u> on core HNu = 50, OVA = 50
30			15.25-17.0' SANDSTONE dusky yellow (5 Y 6/4), fine-grained, well sorted, iron staining, weathered, damp	<u>19.0-21.0' Readings</u> on core HNu = 30, OVA = 50
			<u>17.0-19.0' SAMPLE.</u> Recovered 2 0/20' = 100% SANDSTONE same as above, moist	<u>21.0-23.0' Readings</u> on core HNu = 30, OVA = 50
35			<u>19.0-21.0' SAMPLE.</u> Recovered 2 0/20' = 100% SANDSTONE same as above, wet	<u>23.0-25.0' Readings</u> on core HNu = 30, OVA = 50
			<u>21.0-23.0' SAMPLE.</u> Recovered 2 0/20' = 100% SANDSTONE same as above, moist	<u>25.0-27.0' Readings</u> on core HNu = 30, OVA = 50
40				

LOG OF BOREHOLE

Location Rocky Flats Plant, Mound Area
Coordinates N 36415.15 E 22802.78
Total Depth 45 30'

Borehole/Well No 23-87BR
Ground Surface Elevation 5972.34'
Water Level Encountered 19.0'
Static 5958.39' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 17-21, 1987
Drilling Method Hollow Stem Auger
Logged By S. Rogal; K.D. Hollaway
Geologist

Driller D. Jarvie
Helper J. Duncan
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
40			<u>23.0-25.0' SAMPLE.</u> Recovered 20/20' = 100% SANDSTONE olive gray (5 Y 3/2), mottled, weathered, wet	<u>27.0-29.0' Readings</u> on core HNu = 30, OVA = 50
			<u>25.0-27.0' SAMPLE.</u> Recovered 20/20' = 100% SANDSTONE same as above, wet at 25 6'	<u>29.0-31.0' Readings</u> on core HNu = 30, OVA = 50
45			<u>27.0-29.0' SAMPLE.</u> Recovered 19/20' = 100% SANDSTONE same as above, wet	<u>31.0-33.0' Readings</u> on core HNu = 30, OVA = 50
			<u>29.0-31.0' SAMPLE.</u> Recovered 20/20' = 100% SANDSTONE olive gray (5 Y 3/2), trace silt, mottled, weathered, from 29.0-30.3' damp, 30.3-31' wet	
50			<u>31.0-33.0' SAMPLE.</u> Recovered 20/20' = 100% SANDSTONE same as above with 1/2" gray clay lenses at 31.8', 32.3', 32.8', moist	
			<u>31.4-33.4' SAMPLE.</u> Recovered 20/20' = 100% SANDSTONE dark yellowish orange (10 YR 6/6) to dusky yellow (5 Y 6/4), 3.5-4.0 phi sand, well sorted, interbedded sand, light olive gray (5 Y 6/1), 3.0-2.5 phi, fairly well sorted, wet to moist	
			<u>33.4-35.0' SAMPLE.</u> No recovery Drilled with center bit	

LOG OF BOREHOLE

Location Rocky Flats Plant; Mound Area
Coordinates N 36415.15 E 22802.78
Total Depth 45.30'

Borehole/Well No 23-87BR
Ground Surface Elevation 5972.34'
Water Level Encountered 19.0'
Static 5958.39' (12/01/87)

Drilling Company Boyles Bros
Date Drilled July 17-21, 1987
Drilling Method Hollow Stem Auger
Logged By S. Rogal; K.D. Hollaway
Geologist

Driller D. Jarvie
Helper J. Duncan
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>35.0-36.0' SAMPLE.</u> Recovered 10/10' = 100% SANDSTONE dark yellowish orange (10 YR 6/6) to dusky yellow (5 Y 6/4), sand 3 5-4 0 phi, well sorted, trace clay, wet	
			<u>36.0-37.0' SAMPLE.</u> Recovered 10/10' = 100% SANDSTONE same as above, wet	
			<u>37.0-38.0' SAMPLE.</u> Recovered 10/10' = 100% CLAYEY SANDSTONE olive gray (5 Y 4/1), sand 3 5-4 0 phi, some silt, some clay, unweathered, moist	
			<u>38.0-39.3' SAMPLE.</u> Recovered 13/13' = 100% CLAYEY SANDSTONE same as above, moist	
			<u>39.3-40.3' SAMPLE.</u> Recovered 10/10' = 100% SILTSTONE olive gray (5 Y 4/1) to olive gray (5 Y 3/2), some clay, some 3 5-4 0 phi sand, unweathered, moist	
			<u>40.3-41.3' SAMPLE.</u> Recovered 10/10' = 100% 40 3-40 8' CLAYSTONE olive gray (5 Y 4/1) trace silt, trace 3 5-4 0 phi sand, unweathered, slightly moist to damp 40 8-41 3' SILTSTONE olive gray (5 Y 4/1), some very fine-grained sand, some clay, unweathered, damp to dry	

LOG
OF
BOREHOLE

Location Rocky Flats Plant, Mound Area

Coordinates N 36415.15 E 22802.78

Total Depth 45.30'

Borehole/Well No 23-87BR

Ground Surface Elevation 5972.34'

Water Level Encountered 19.0'

Static 5958.39' (12/01/87)

Drilling Company Boyles Bros

Driller D. Jarvie

Date Drilled July 17-21, 1987

Helper J. Duncan

Drilling Method Hollow Stem Auger

Drilling Fluid None

Logged By S. Rogal; K.D. Hollaway
Geologist

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>41.3-42.3' SAMPLE.</u> Recovered 0/10' = 0% SILTSTONE same as above, dry	
			<u>42.3-43.3' SAMPLE.</u> Recovered 10/10' = 100% SILTSTONE same as above, trace very fine-grained sand, dry	
			<u>43.3-44.3' SAMPLE.</u> Recovered 10/10' = 100% SILTSTONE same as above, dry	
			<u>44.3-45.3' SAMPLE.</u> Recovered 10/10' = 100% SILTSTONE same as above except more sand, dry	
			TOTAL DEPTH 45.30'	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant; Mound Area

Coordinates N 36415.15 E 22802.78

Total Depth Well 37.85'

Borehole 45.30'

Formation of Completion Arapahoe Formation

Casing Material Sch 5, type 316 TFJ stainless steel

Screen Material 0.010" wire wrap, type 316 TFJ stainless steel

Date Installed July 24, 1987

Installed By K.D. Hollaway
Geologist

Well No 23-87BR

Elevation Ground Surface 5972.34'

Top of Casing 5974.49'

Casing Diameter 2" ID

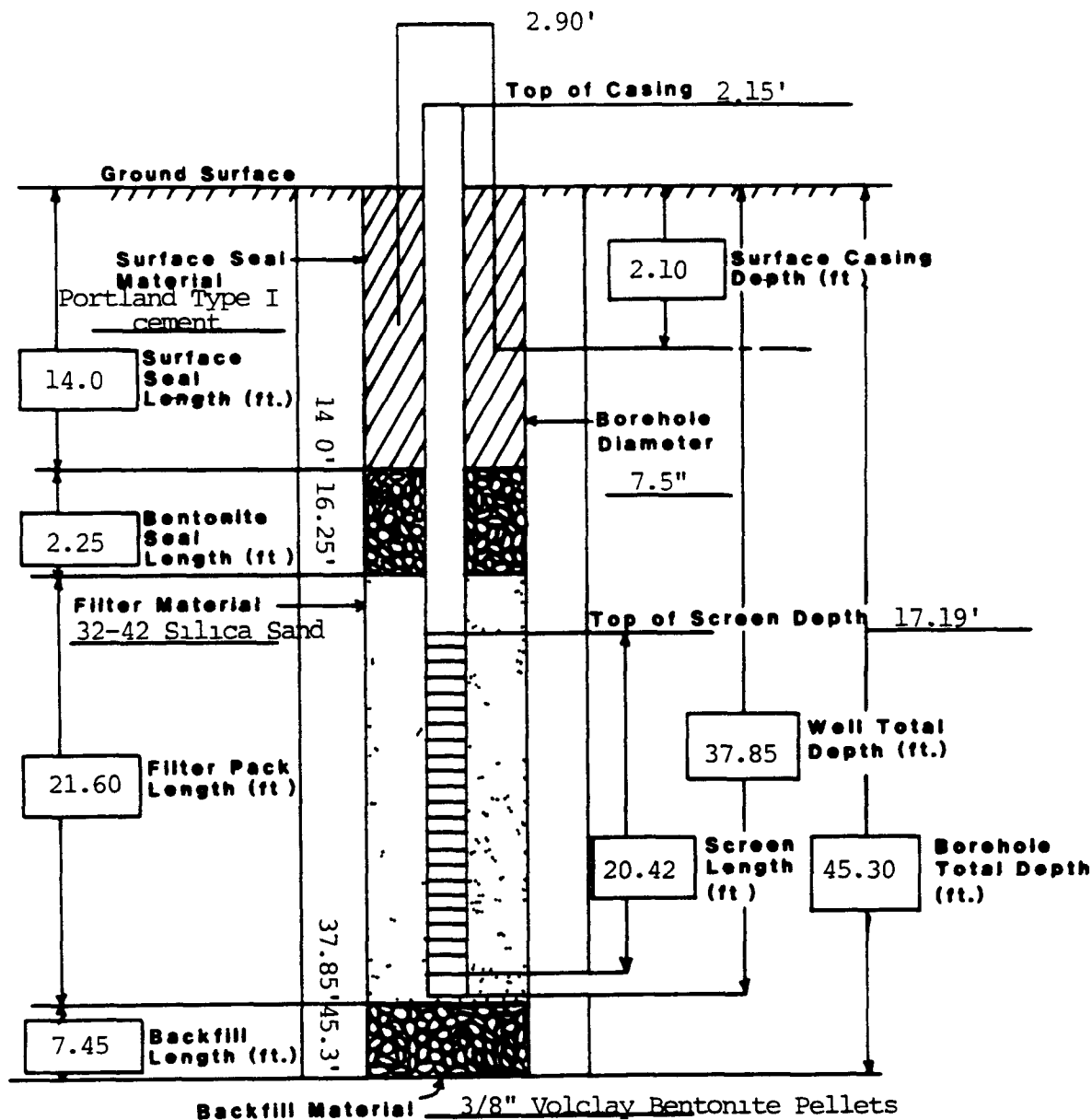
Surface Casing Diameter 5" ID

Approved By _____

Site Manager

CEARP Manager

Comments _____



INDEX OF DATA

Boring No 37-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Pond Area
Coordinates N 37507.14 E 22119.81
Total Depth 13 0'

Borehole/Well No 37-87
Ground Surface Elevation 5967.03'
Water Level Encountered None
Static 5962.42' (4/18/88)

Drilling Company Boyles Bros
Date Drilled October 26, 1987
Drilling Method Hollow Stem Auger
Logged By R. Treat
Geologist

Driller T High
Helper B Keenev
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
			<u>0.0-2.0' SAMPLE</u> Recovered 1 11/20' = 70% GRAVEL AND SAND moderate brown (5 YR 3/4) to grayish brown (5 YR 3/2), medium and coarse sand with small gravel (0.55 mm to 2.25 mm), subangular, angular and few subrounded, weakly cemented, light, moist	HNu background=0.6 OVA background = 2.6 Ludlum background = 0.0
5			<u>2.0-4.0' SAMPLE</u> Recovered 1 7/20' = 85% 2.0-2.7' GRAVEL AND SAND same as above	<u>2.0-3.7' Readings in augers</u> HNu = 0.2, OVA = 3.2
10			<u>ROCKY FLATS ALLUVIUM</u>	
			2.7-3.7' CLAYEY GRAVEL reddish brown, weakly to moderately cemented, poorly sorted, angular and subangular gravels, few rounded, slightly calcareous, light moist	
15			<u>4.0-7.0' SAMPLE</u> Recovered 0.8/3.0' = 27% CLAYEY GRAVEL same as above	
			<u>7.0-9.5' SAMPLE</u> Recovered 2.5/2.5' = 100% 7.0-8.5' SAND AND GRAVEL light brown (5 YR 5/6) to a moderate brown (5 YR 4/4) sand, well-sorted and range (2.0-1.5 mm) to 0.5-0.0 Ø with gravel 0.25 mm to 1.5 mm and scattered large size, medium dense, weakly cemented, moist	
20				

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Pond Area
Coordinates N 37507.14 E 22119.81
Total Depth 13 0'

Borehole/Well No 37-87 (cont'd.)
Ground Surface Elevation 5967.03'
Water Level Encountered None
Static 5962 42' (4/18/88)

Drilling Company Boyles Bros
Date Drilled October 26, 1987
Drilling Method Hollow Stem Auger
Logged By R. Treat
Geologist

Driller T High
Helper B. Keeney
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARAPAHOE FORMATION</u>	
			8 5-9 5' CLAYSTONE light gray (N 7/0) medium plastic, very calcareous in upper 12" to slightly calcareous, streaked and highly effervescess with HCl massive blocky, weathered, moist	
<u>5</u>			<u>9 5-13 0' SAMPLE</u> Recovered 3 5/3 5' = 100% CLAYSTONE light gray (N 7/0) to vary- ing brownish gray, slightly oxide stained, blocky, massive, highly to moderately plastic, weathered, moist	
			TOTAL DEPTH 13 0'	
<u>10</u>				
<u>15</u>				
<u>20</u>				

WELL COMPLETION INFORMATION

Location Rock Flats Plant, Solar Ponds Area

Well No 37-87

Coordinates N 37507.14 E 22119.81

Elevation Ground Surface 5967.03'

Total Depth Well 9.0'

Top of Casing 5969.02'

Borehole 13.0'

Formation of Completion Rocky Flats Alluvium

Casing Material Sch 5, Type 316, TFJ Stainless Steel

Casing Diameter 2" ID

Screen Material 0.010" wire wrap, Type 316, TFJ Stainless Steel

Surface Casing Diameter 5" ID

Date Installed October 27, 1987

Approved By _____

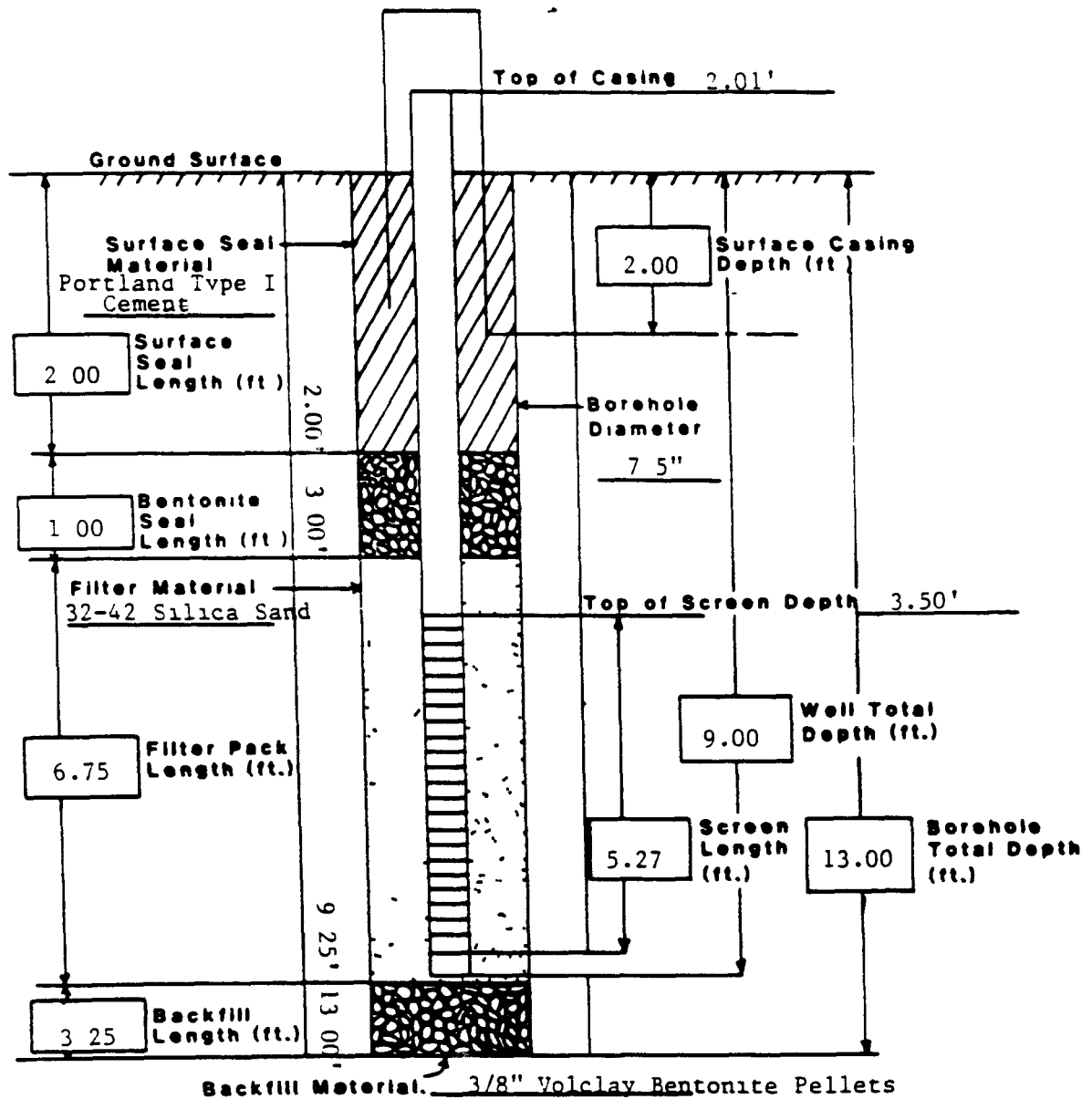
Installed By R. Treat

Geologist

Site Manager

CEARP Manager

Comments _____



INDEX OF DATA

Boring No 37-87A

Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data
and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates * N 37503 E 22120

Total Depth 14.5'

Drilling Company Bovles Bros

Date Drilled October 26, 1987

Drilling Method Hollow Stem Auger

Logged By R. Treat
Geologist

Borehole/Well No 37-87A

Ground Surface Elevation *5967'

Water Level Encountered None

Static N/A

Driller T. High

Helper R. Keeney

Drilling Fluid None

Checked By _____

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement.

*Coordinates and elevation estimated from topographic map.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
			<u>0.0-2.0' SAMPLE</u>	
			Recovered 1 3/2 0' = 65%	
			SAND AND GRAVEL moderate brown (5 YR 4/4) to grayish brown (5 YR 3/2) with sand ranging from 30-15 Ø and finer-grained, gravel (0.75 mm to 4.5 mm), angular and subangular, poorly sorted, weakly cemented with scattered cobbles to 2', light moist	
5			<u>2.0-4.0' SAMPLE</u>	
			Recovered 1 0/2 0' = 50%	
			2.0-2.5' SAND AND GRAVEL same as above	
10			<u>ROCKY FLATS ALLUVIUM</u>	
			2.5-3.0' CLAY AND GRAVEL dusky brown (5 YR 2/2), varying browns with fine-grained sand, gravel angular to subangular, few rounded, calcareous, moderately cemented, low plastic, light moist	
15			<u>4.0-7.0' SAMPLE</u>	
			Recovered 0 3/3 0' = 10%	
			CLAYEY SAND AND GRAVEL moderate yellowish brown (10 YR 5/4) slough, fine to medium-grained sand with gravel	
20				

LOG
OF
BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area
Coordinates * N 37503 E 22120
Total Depth 14.5'

Drilling Company Bovles Bros
Date Drilled October 26, 1987
Drilling Method Hollow Stem Auger
Logged By R Treat
Geologist

Borehole/Well No 37-87A (cont'd.)
Ground Surface Elevation *5967'
Water Level Encountered None
Static N/A
Driller T. High
Helper B. Keeney
Drilling Fluid None
Checked By _____
Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement.
*Coordinates and elevation estimated from topographic map.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>7.0-9.5' SAMPLE</u> Recovered 10/25' = 40% SAND AND GRAVEL light brown (5 YR 5/6), 15-10 mm, gravel to 275 mm, subangular to angular, weakly cemented, poorly sorted, moist	
			<u>9.5-12.0' SAMPLE</u> Recovered 00/25' = 0%	
			<u>12.0-14.5' SAMPLE</u> Recovered 00/25' = 0%	
			TOTAL DEPTH 14.5	

INDEX OF DATA

Boring No 38-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Pond Area
Coordinates N 37370 70 E 22020.53
Total Depth 14 0'

Borehole/Well No 38-87

Ground Surface Elevation 5971.79'

Water Level Encountered None

Static Dry (4/18/88)

Drilling Company Boyles Bros

Driller T High

Date Drilled October 27, 1987

Helper B Keeney

Drilling Method Hollow Stem Auger

Drilling Fluid None

Logged By R. Treat
Geologist

Checked By _____
Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
		<u>00-20' SAMPLE</u>		
		Recovered 08/20 = 45%		HNu background=0.4
		GRAVEL AND SAND very pale orange		OVA background =
		(10 YR 8/2) to dark brown with gravel		0.6
		subangular, angular (0.5 mm to 3.25 mm)		Ludlum background
		with possible scattered cobbles, fine-		= 0.0
		grained sand, weakly cemented, light		No readings above
		moist		background
5				
		<u>2.0-4.0' SAMPLE</u>		
		Recovered 08/20 = 45%		
		GRAVEL slightly sandy to very sandy,		
		sand range (3.0-2.5 Ø) to (2.5-1.0 Ø) with		
		gravel (0.75 mm to 3.25 mm), angular,		
		calcareous, weakly cemented subangular,		
		well to poorly sorted, light moist		
10				
		<u>ROCKY FLATS ALLUVIUM</u>		
		<u>4.0-7.0' SAMPLE</u>		
		Recovered 12/30 = 40%		
		SAND AND GRAVEL light brown (5 YR		
		5/6) to pale brown (5 YR 5/2) with sand		
		(3.0-2.5 Ø) and scattered sands (1.5-1.0		
		mm), gravel (0.25 mm to 2.00 mm), weakly		
		cemented, poorly sorted, angular-		
		subangular gravel, light moist		
15				
20				

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, Solar Ponds Area

Well No 38-87

Coordinates N 37370.70 E 22020.53

Elevation Ground Surface 5971.79'

Total Depth Well 9.50'

Top of Casing 5973.95'

Borehole 14.00'

Formation of Completion Rocky Flats Alluvium

Casing Material Sch 5, Type 316, TFJ Stainless Steel

Casing Diameter 2" ID

Screen Material 0.010" wire wrap, Type 316, TFJ Stainless Steel

Surface Casing Diameter 5" ID

Date Installed October 28, 1987

Approved By _____

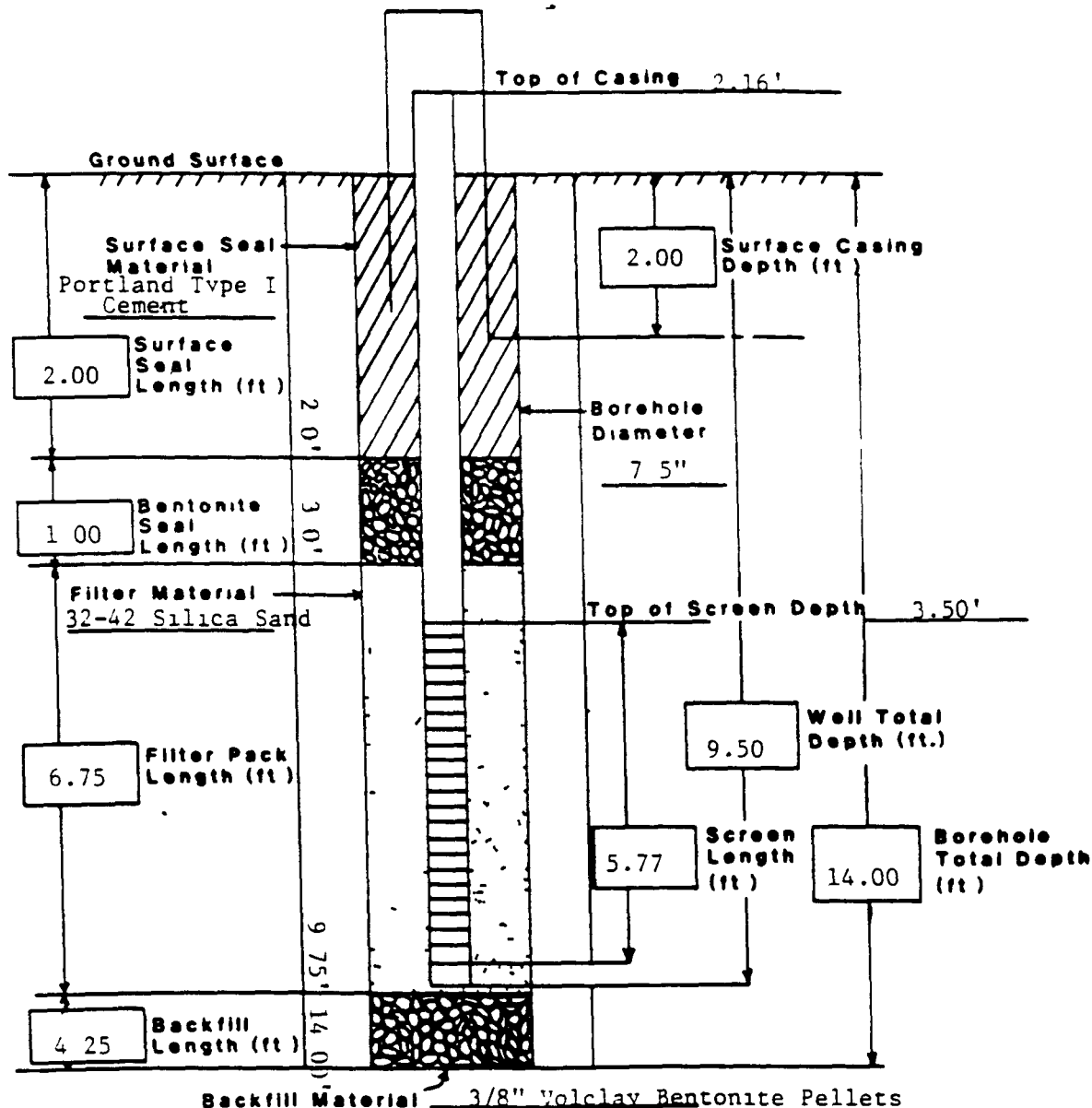
Installed By R. Treat

Site Manager

Geologist

CEARP Manager

Comments _____



LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't.)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>6.5-9.0 SAMPLE.</u> Recovered 20/25 = 80% SANDSTONE light gray (N 7/0) to severely oxide stained brown, fine-grained sand (30-25 Ø), weakly cemented massive, slight clay binder weathered moist	<u>19.0'</u> Readings in augers HNu = 0, OVA = 28
25			<u>9.0-11.5 SAMPLE</u> Recovered 25/25 = 100% CLAYEY SANDSTONE varying oxide (Fe) browns to grays, fine-grained sand as above, massive, weakly cemented, weathered, moist	
30			<u>11.5-14.0' SAMPLE.</u> Recovered 15/25 = 60% CLAYEY SANDSTONE as stated above continued moderately oxide stained, weathered	
35			<u>14.0-16.5' SAMPLE.</u> Recovered 20/25 = 80% CLAYEY SANDSTONE light gray (N 7/0) to severely oxide stained brown, sand (30-25 Ø), massive, low plastic, weakly to moderately cemented, weathered, moist	
40			<u>16.5-19.0' SAMPLE</u> Recovered 23/25 = 92% CLAYEY TO VERY CLAYEY SANDSTONE oxide stained brown to light gray low plastic massive, weakly cemented, weathered, moist	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
40			<p><u>19.0-21.5' SAMPLE.</u> Recovered 1 4/2 5' = 56% CLAYEY SANDSTONE moderately oxide stained to light gray (N 7/0) massive, fine-grained, weathered, moist</p> <p><u>21.5-24.0' SAMPLE</u> Recovered 1 8/2 5' = 72% CLAYEY SANDSTONE light gray (N 7/0) to severely oxide stained brown, low plastic sands (3.5-3.0 Ø to 2.5-2.0 Ø), weakly cemented, massive, moist</p> <p><u>24.0-26.5' SAMPLE</u> Recovered 1 2/2 5' = 60% 24.0-25.0' CLAYEY SANDSTONE as noted above moist 25.0-25.2' CLAYSTONE medium gray (N 4/0), massive, blocky, remaining slightly sandy (3.5-3.0 Ø), low plastic, weathered moist</p> <p><u>26.5-29.0' SAMPLE</u> Recovered 2 5/2 5' = 100% CLAYSTONE medium gray (N 7/0) massive medium plastic slightly blocky now only slightly oxide stained in streaks at 28.5 and 28.8 for 2' streaks</p> <p><u>29.0-31.5' SAMPLE.</u> Recovered 1 3/2 5' = 52% SANDY CLAYSTONE as noted above but now moderately oxide (Fe) stained, massive, medium plastic, weathered, moist</p>	<p><u>50.10-59.75' Packer</u> Test Interval #10</p> <p><u>59.75-69.40' Packer</u> Test Interval # 9</p>
45				
50				
55				
60				

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
80			<p><u>41.3-45.4 SAMPLE</u> Recovered 1 68/4 10' = 41% RQD = 1 04/1 68' = 62%</p> <p>41.3-41.8' CLAYSTONE PLUG</p> <p>41.8-42.35' SILTY CLAYSTONE dark gray (N 3/0) to olive black (5 Y 2/1), some very fine-grained sand, well sorted, unconsolidated, blocky, soft to medium hardness, damp</p> <p>42.35-44.03' SANDY SILTY CLAYSTONE olive black (5 Y 2/1), sand very fine-grained (3.5-4.0 Ø), well sorted, consolidated, blocky, medium hardness, some organics, damp</p> <p><u>45.4-49.5' SAMPLE</u> Recovered 4 10/4 10' = 100% RQD = 3 55/4 10' = 87%</p> <p>SANDY CLAYSTONE olive gray (5 Y 4/1) to olive black (5 Y 2/1), sand very fine-grained (3.5-4.0 Ø), well sorted, occasional lenses of a coarser grained sand (3.0-2.5 Ø), pinkish gray (5 YR 8/1) increasing down core when get into sandstone/claystone interbeds, consolidated, hard, at 45.80' have a leaf imprint, occasional organics throughout core, damp</p>	<p><u>79.05-88.70'</u> Packer Test Interval # 7</p> <p><u>88.70-98.35</u> Packer Test Interval # 6</p> <p><u>98.35-108.00'</u> Packer Test Interval # 5</p>
85				
90				
95				
100				

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
100			<p><u>49.5-54.0 SAMPLE.</u> Recovered 4 20/4 50' = 93 30% RQD = 2 70/3 90' = 69% 49 5-50 7' SANDY CLAYSTONE olive gray (5 Y 3/2), cuttings from above, moist 50 7-54 0' SANDY CLAYSTONE olive gray (5 Y 4/1) to olive black (5 Y 2/1), same as 45 40-49 50' interval, at 52 25' have some fine-grained sand stained dark yellowish orange (10 YR 6/6) lenses of fine-grained sand increase down core, at 53 5-54 0 clay is predominant, damp</p>	<p><u>108.00-117.65</u> Packer Test Interval # 4 <u>115.65-125.30</u> Packer Test Interval # 3 <u>117.65-127.30</u> Packer Test Interval # 2 <u>122.68-132.33</u> Packer Test Interval # 1</p>
105			<p><u>54.0-57.0 SAMPLE</u> Recovered 3 3/3 0 = 110% RQD = 2 45/3 30 = 74% SANDY (LAYSTONE same as above with nodules of very pale orange (10 YR 8/2) clay and very fine-grained sand in creasing down core at 56 22 have leaf imprint less fine-grained sand lenses damp</p>	
110			<p><u>57.0-61.0 SAMPLE.</u> Recovered 4 0/4 0' = 100% RQD = 4 0/4 0' = 100% SANDY CLAYSTONE same as above with more fine-grained sand lenses, clay nodules still present, more organics than above, clay increases down core with 60 0-61 0' mostly clay, damp</p>	
115			<p><u>61.0-65.0 SAMPLE.</u> Recovered 0 0/4 0' = 0% Lost core</p>	
120				

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't.)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
120			<p><u>65 0-66 0' SAMPLE</u> Recovered 15/10' = 150% RQD = 0% CLAYSTONE light greenish gray (5 GY 4/1) to dark greenish gray (5 GY 2/1) from 65 0-65 3', rest of core olive black (5 Y 2/1), trace very fine-grained sand, core mangled from drilling, appears unconsolidated and blocky, damp to moist</p>	
125			<p><u>66 0-70 0' SAMPLE</u> Recovered 50/40' = 125% RQD = 26/50' = 52% 66 0-67 5 CLAYSTONE olive black (5 Y 2/1) to brownish black (5 YR 2/1), trace silt and very fine-grained sand, some organics, blocky, consolidated, damp 67 5-68 5 CLAYSTONE olive black (5 Y 2/1) to brownish black (5 YR 2/1), trace silt and very fine-grained sand, some organics blocky, consolidated, damp 68 5-69 5 CLAYSTONE olive black (5 Y 2/1) to greenish black (5 GY 2/1) to black (N 1/0), trace silt, blocky, damp 69 5-70 0' CLAYSTONE medium bluish gray (5 B 5/1) to medium gray (N 5/0), highly plastic, block, moist</p>	
130				
135			<p><u>70 0-74 0' SAMPLE</u> Recovered 06/40 = 15% RQD = 0% CLAYSTONE olive black (5 Y 2/1) to medium dark gray (N 4/0) blocky homogenous plastic damp</p>	
140				

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>74 0-76.0 SAMPLE</u> Recovered 3 85/2 0' = 193% RQD = 2 26/3 85' = 59% Picked up 1 85' from previous run 72 15-74 0 CLAYSTONE olive black (5 Y 2/1) with lenses of black (N 1/0), blocky, homogenous, plastic, damp 74 0-76 0 CLAYSTONE olive black (5 Y 2/1) to medium gray (N 5/0), blocky, homogenous, plastic, damp <u>76.0-80 0 SAMPLE</u> Recovered 2 13/4 0 = 53% RQD = 1 50/2 13' = 70% CLAYSTONE olive black (5 Y 2/1), some silt some organics trace very fine-grained sand interbeds, homogenous, blocky, medium hardness, damp <u>80 0-82 0' SAMPLE</u> Recovered 2 62/2 01 = 131% RQD = 1 62/2 62' = 62% SANDY CLAYSTONE olive black (5 Y 2/1), some very fine-grained sand, poorly sorted, subangular to subrounded fine-grained sand occurring in lenses and interbeds, some silt, some organics, small coal seams, blocky, fairly homogenous, medium hardness, damp	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>820-840 SAMPLE</u> Recovered 2 38/20' = 119% RQD = 2 15/2 38' = 90% SANDY CLAYSTONE/CLAYEY SAND- STONE INTERBEDS olive black (5 Y 2/1) to dark gray (N 3/0), sand very fine- grained to fine-grained, poorly sorted, occurs in lenses and interbeds, occasional stringers of coal in small fractures with no orientation, some silt, some organics, consolidated medium hardness from 830-840 have small lenses of fairly well sorted fine-grained (30-25 Ø) sand subrounded, quartzitic, yellowish gray (5 Y 8/1) damp with sand lenses moist	
			<u>840-860 SAMPLE</u> Recovered 20/20 = 100% RQD = 1 76/20' = 86% SANDY CLAYSTONE olive black (5 Y 2/1) to dark gray (N 3/0) with yellowish gray (5 Y 8/1) fine-grained sand lenses occasional, poorly sorted, occasional stringers of coal, some silt, some organics, consolidated, damp	
			<u>860-880' SAMPLE</u> Recovered 20/20' = 100% RQD = 20/20' = 100% SANDY SILTSTONE same as above except less sand, no coal stringers, damp	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't.)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>88.0-92.0' SAMPLE.</u> Recovered 40/40 = 100% RQD = 3 63/40' = 91% 88.0-91.0 SANDY SILTSTONE olive black (5 Y 2/1) and dark gray (N 3/0), some clay, lots of silt, some very fine- grained fairly well sorted sand with lenses of a fine-grained, well sorted sand, damp 91.0-92.0 SILTY SANDSTONE olive black (5 Y 2/1) with yellowish gray (5 Y 8/1) to pinkish gray (5 YR 8/1) fine- grained sand, fairly well sorted, sand in lenses and interbeds, some clay some organics small planes of lamination present in sand lenses, consolidated, damp <u>92.0-96.0' SAMPLE</u> Recovered 40/40 = 100% RQD = 3 83/40' = 96% 92.0-94.25' SILTY SANDSTONE olive black (5 Y 2/1) to yellowish gray (5 Y 8/1), very fine-grained to fine-grained sand, fairly well sorted some planes of lamination, less silt and clay than above some occasional organics, consolidated damp 94.25-95.2 SANDY SILTSTONE/SILTY SANDSTONE same as above with finer- grained sand, damp 95.2-96.0 SILTY SANDSTONE same as 92.0-94.25 damp	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>960-1000 SAMPLE</u> Recovered 4 3/4 0' = 107% ROD = 40/43' = 93% 960-9735' SANDY SILTSTONE olive black (5 Y 2/1), very fine-grained sand, fairly well sorted in siltstone matrix, some clay, some organics, some lamination planes, consolidated, at 9610-9650' and 972-9735' have lenses of a light olive gray (5 Y 6/1) to olive black (5 Y 2/1), fairly well sorted, moist, fine-grained sand, damp 9735-990 SILTSTONE olive black (5 Y 2/1), very fine-grained sand yielding to claystone downcore and disappearing at 9885', consolidated, some clay, lots silt, occasional nodules of grayish orange (10 YR 7/4) clay, prominent from 9735-980', some organics, damp 990-1000' CLAYEY SILTSTONE olive black (5 Y 2/1), trace very fine-grained sand, lots of silt, lots of clay, consoli- dated, some organics, occasional grayish orange (10 YR 7/4) nodules of clay, damp	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>100.0-104.0' SAMPLE.</u> Recovered 2 61/40' = 65 3% RQD = 2 50/2 61 = 96% 100 0-101 0' CLAYEY SILTSTONE olive black (5 Y 2/1), trace very fine-grained sand, fairly homogenous, consolidated, damp 101 0-101 5' SILTY SANDSTONE yel- lowish gray (5 Y 8/1) to olive black (5 Y 2/1), sand from very fine-grained in upper portion to fine-grained in lower portion fairly well sorted, subrounded, some silt, little clay, consolidated, damp to moist 101 5-102 61' CLAYSTONE medium dark gray (N 4/0) to dark gray (N 3/0), highly plastic, blocky, homogenous no silt or sand, damp to moist <u>104 0-108.0' SAMPLE.</u> Recovered 4 0/40' = 100% RQD = 3 27/40' = 82% CLAYSTONE olive black (5 Y 2/1) to dark gray (N 3/0), trace silt, blocky, homogenous, damp to moist	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't.)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>1080-112.0' SAMPLE.</u> Recovered 3 9/40' = 98% RQD = 3 49/39' = 89.5% 1080-1100' SILTSTONE olive black (5 Y 2/1), some very fine-grained sand, some clay, some organics, fairly homogenous, consolidated, hard, more sand down core, damp 1100-11190' SANDSTONE dark greenish gray (5 G 4/1) to greenish gray (5 GY 6/1) with some yellowish gray (5 Y 8/1), very fine-grained (3.5-4.0 Ø) to fine-grained (3.0-2.5 Ø) fairly well sorted subangular to subrounded, some silt, trace clay, some leaf and plant stem organics, increases down core, sand fines as goes down core with occasional lenses of the coarser grains, massive, damp to moist</p>	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>112.0-116.0' SAMPLE.</u> Recovered 4 67/40' = 117% RQD = 3 23/4 67' = 69% 112.0-112.5 SANDY SILTSTONE olive black (5 Y 2/1), 40% silt, 40% organics, 20% sand, consolidated, damp to moist 112.5-115.75' SANDSTONE greenish gray (5 GY 6/1) to dark greenish gray (5 G 4/1) with some yellowish gray (5 Y 8/1), fine-grained (30-20 Ø) to medium- grained (20-15 Ø) sand, fining down core, occasional lenses of clay and silt associated with organics occurring throughout the core, sand massive with zones of contorted bedding, consolidated, at 112.75 have a fracture of coal with small fractures of coal or organics occur- ring throughout the core, damp to moist 115.75-116.0 SILTY SANDSTONE olive black (5 Y 2/1) very silty sand fine- grained to medium-grained as above occurring in lenses many organics with clay associated very hard consolidated damp	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>1160-120.0' SAMPLE</u> Recovered 20/40' = 50% RQD = 045/20 = 22.5% 1160-1163 CUTTINGS OF SILTSTONE AND CLAYSTONE reworked 1163-1169' SANDY SILTSTONE olive black (5 Y 2/1) with yellowish gray (5 Y 8/1) and greenish gray (5GY 6/1) fine- grained sand in lenses, some clay, some organics, massive, consolidated, damp to moist 1169-1180' CLAYEY SANDY SILT- STONE olive black (5 Y 2/1), heavy silt influence, sand is very fine-grained, some organics, massive, consolidated, damp	

LOG OF BOREHOLE

Location _____

Coordinates _____

Total Depth _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By _____

Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>120.0-122.0' SAMPLE</u> Recovered 4 6/20' = 230% RQD 3 97/46' = 86% 118.0-120.0' CLAYEY SILTSTONE olive black (5 Y 2/1) to greenish black (5 GY 2/1), trace very fine-grained sand, some organics, occasional seams of coal, massive blocky, fairly homogenous, consolidated, damp 120.0-121.4 CLAYEY SILTSTONE dark greenish gray (5 G 4/1) to greenish black (5 GY 2/1), trace very fine-grained sand in lenses, some organics, massive, consolidated damp 121.4-122.0 SANDSTONE dark greenish gray (5 G 4/1) to greenish black (5 GY 2/1), some silt in top of core giving way to sand, fine-grained to medium-grained (20-15 Ø) sand, subrounded to subangular, feldspathic and quartzitic, fairly well sorted, massive, homogenous, consolidated, few organics, damp to moist	

LOG OF BOREHOLE

Location _____

Coordinates _____

Total Depth _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By _____

Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>122 0-126 0 SAMPLE</u> Recovered 4 0/4 0 = 100% RQD = 3 65/4 0' = 91% 122 0-122 85' SANDSTONE greenish gray (5 G 6/1) to greenish black (5 G 2/1), some silt, fine-grained to medium-grained (2 5-1 5 Ø) sand, subrounded to subangular, fairly well sorted, some organics, massive, consolidated, moist 122 85-126 0' SANDSTONE/SILTSTONE greenish gray (5 G 6/1) to greenish black (5 G 2/1), very fine-grained sand with lenses of fine-grained to medium-grained sand as above (122 0-122 85), some organics more than above, clay influence with organics, sand decreases down core giving way to more silt, a little clay, and more organics massive, consolidated, damp</p> <p><u>126 0-130 0' SAMPLE</u> Recovered 1 5/4 0' = 37 5% RQD = 0 75/1 5' = 50% SANDSTONE medium dark gray (N 4/0) to light gray (N 7/0), very fine-grained to fine-grained (3 5-2 5 Ø) feldspathic and quartzitic sand, fairly well sorted, massive, occasional trace lamination planes, sand fines down core, some organics, some silt, from 127 3-127 5' have zone of clay influence, moist to wet</p>	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>1300-1320 SAMPLE</u> Recovered 4 35/20' = 217 5% RQD = 3 68/4 35 = 84 6% 127 5-129 4 CLAYEY SILTSTONE dark greenish gray (5 G 4/1) to greenish black (5 G 2/1), no organics, hard, massive, fairly homogenous, consolidated, damp to dry 129 4-129 7 SILTY CLAYSTONE same as above damp to dry 129 7-130 0 SILTY SANDSTONE same as above with some clay very fine-grained sand moist 1300-1320 SILTY SANDSTONE dark greenish gray (5 G 4/1) to greenish gray (5 G 6/1) very fine-grained (3 5-40 Ø) to fine-grained (3 0 25 Ø) fairly well sorted sand some silt massive consolidated damp to moist <u>1320-1360 SAMPLE</u> Recovered 4 18/40' = 104 5% RQD = 3 76/4 18' = 90% 1320-1324' SANDSTONE dark greenish gray (5 G 4/1) to greenish gray (5 G 6/1), fine-grained (20-30 Ø) sand, fairly well sorted, some silt, massive, consolidated, damp 1324-1360' SILTY CLAYSTONE dark greenish gray (5 G 4/1) to greenish gray (5 G 6/1), trace very fine-grained sand, silt in top of core gives way to clay down core fairly homogenous, massive, consoli- dated, hard, no organics, damp	

LOG
OF
BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist _____

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>136.0-140.0 SAMPLE</u></p> <p>Recovered 20/40' = 50%</p> <p>RQD = 06/20' = 30%</p> <p>CLAYSTONE medium gray (N 5/0) to dark gray (N 3/0), some silt, homogenous, massive, blocky, no organics, damp</p> <p>TOTAL DEPTH 140.00'</p>	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, Solar Ponds Area

Well No 39-87BR/SP08-87

Coordinates N 38094.04 E 22166 32

Elevation Ground Surface 5947 10'

Total Depth Well 117 39'

Top of Casing 5949 12'

Borehole 140.00'

Formation of Completion Arapahoe Formation

Casing Material Sch 5, Type 316, TFJ Stainless Steel

Casing Diameter 2" ID

Screen Material 0.010" wire wrap, Type 316, TFJ Stainless Steel

Surface Casing Diameter 5" ID

Date Installed November 17-18, 1987

Approved By _____

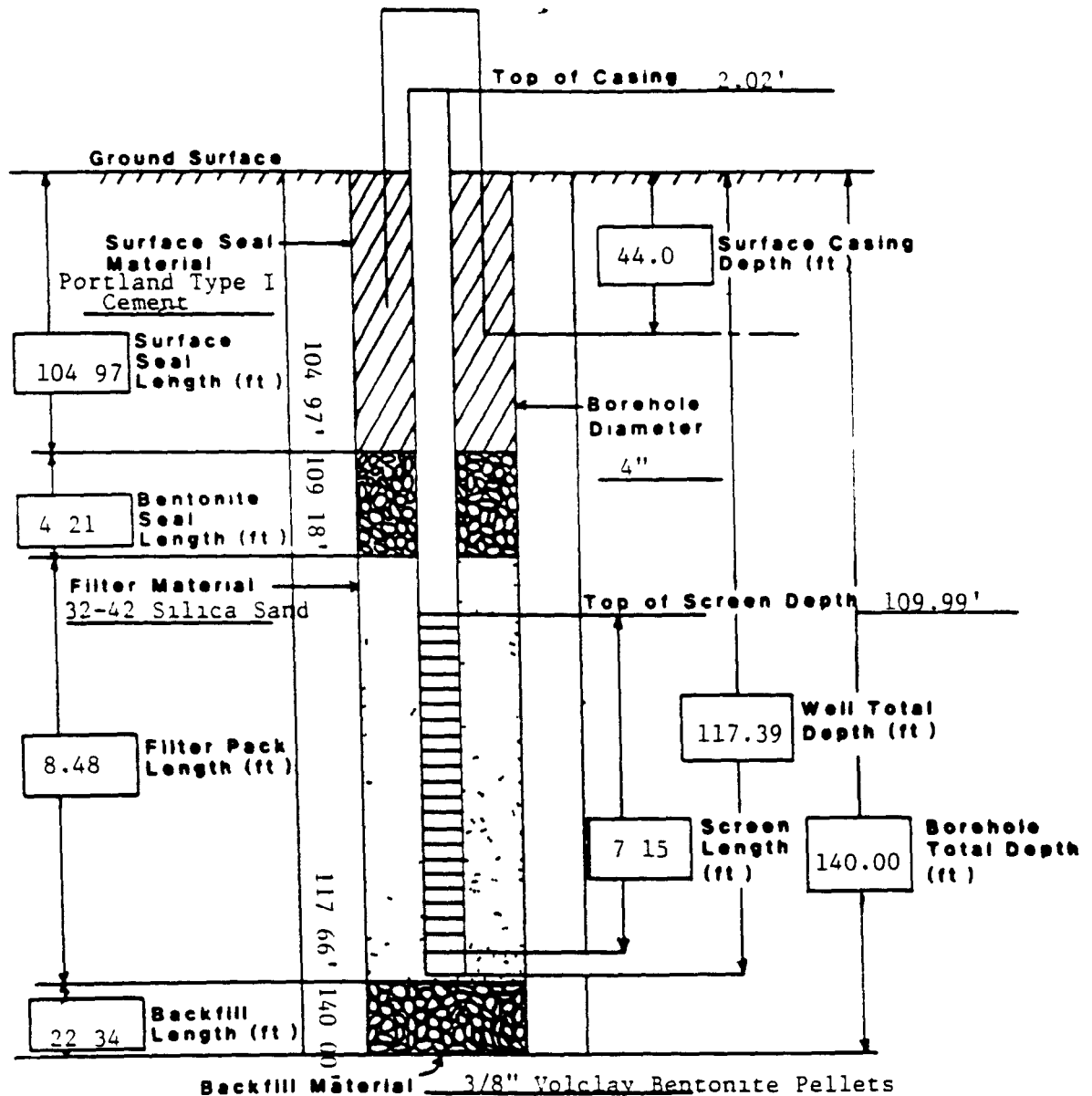
Installed By K D Hollaway

Site Manager _____

Geologist _____

CEARP Manager _____

Comments Surface casing set to 44 0' by R Treat on October 30, 1987.



INDEX OF DATA

Boring No 51-87/BH62-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

LOG OF BOREHOLE

Location <u>Rocky Flats Plant, 881 Hillside Area</u>	Borehole/Well No <u>51-87/BH62-87</u>
Coordinates <u>N 35120 00 E 20738 10</u>	Ground Surface Elevation <u>5963.30'</u>
Total Depth <u>18.00'</u>	Water Level Encountered <u>12 00'</u>
	Static <u>5948 76' 2/4/88</u>
Drilling Company <u>Boyles Bros</u>	Driller <u>S Bradfield</u>
Date Drilled <u>October 21, 1987</u>	Helper <u>P Mesa</u>
Drilling Method <u>Hollow Stem Auger</u>	Drilling Fluid <u>None</u>
Logged By <u>R.T. Treat</u> Geologist	Checked By _____ Site Manager
	CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL</u>	
			<u>0.0-2.0' SAMPLE</u> Recovered 0 8/2 0' = 40%	HNu background=0 2 OVA background=0 4 Ludlum readings taken and no readings over background, on core
			<u>0.0-0.5' ASPHALT SURFACING</u>	
			<u>0.5-0.8' SAND AND GRAVEL</u> varying browns, weakly cemented, medium- and coarse-grained sands with small and medium size gravels ranging 0.25 mm up to 3.25 mm, rounded and subrounded, moist (most soils man made fill appearing as a base for asphalt surface)	Field screen readings sample reading (field screen reading)
5			<u>2.0-4.0' SAMPLE</u> Recovered 1 5/2 0' = 75%	<u>0.0-0.8' Field screen readings HNu = 0 0 (0 0), OVA = 0 0 (0 0)</u>
			<u>2.0-2.5' SAND AND GRAVEL</u> same as above	<u>0.0-8.0' Composite sample BH62870008 Duplicate sample BH6287008D</u>
10			<u>ROCKY FLATS ALLUVIUM (DISTURBED)</u>	
			<u>2.5-3.5' CLAY WITH SOME CLAY- STONE FRAGMENTS</u> grayish brown (5 YR 3/2) to moderate reddish brown (10 R 4/6), sandy with scattered gravels, moderately cemented, moist	<u>2.0-3.5' Field screen readings HNu = 0 0 (0 0), OVA = 0 0 (0 0)</u>
15			<u>4.0-6.0' SAMPLE</u> Recovered 1 5/2 0' = 75%	<u>4.0-5.5' Field screen readings HNu = 0 0 (0 0), OVA = (0 0 (0 0)</u>
			<u>CLAY</u> varying gray to reddish browns, slightly sandy, fine-grained (2.5-2.0Ø), few scattered gravels, weakly cemented, poorly sorted, moist	
20				

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 51-87/BH62-87
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>60-80' SAMPLE</u> Recovered 20/20' = 100% CLAY varying brown to grayish brown, claystone fragments, slightly sandy with scattered gravel 100 mm up to 25 mm, rounded and subrounded, weakly cemented, medium plastic, moist	<u>60-80'</u> Field screen readings HNu = 02 (04), OVA = 00 (00)
			<u>80-100' SAMPLE</u> Recovered 00/20' = 0% CLAY same as above	
			<u>100-120' SAMPLE</u> Recovered 00/20' = 0% Cuttings described CLAY WITH CLAYSTONE FRAGMENTS same as above	
			<u>120-125' SAMPLE</u> No recovery Drilled with center bit	
			<u>125-140' SAMPLE</u> Recovered 15/15' = 100% 125-135' CLAY AND GRAVEL varying gray and brown, claystone fragments with clay and some scattered gravel, weakly cemented, moist	<u>125-140'</u> Contact sample BH628712CT
			<u>ARAPAHOE FORMATION</u> 135-140' CLAYSTONE dark gray (N 3/0), massive, blocky, medium plastic, weathered, moist	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 51-87/BH62-87
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

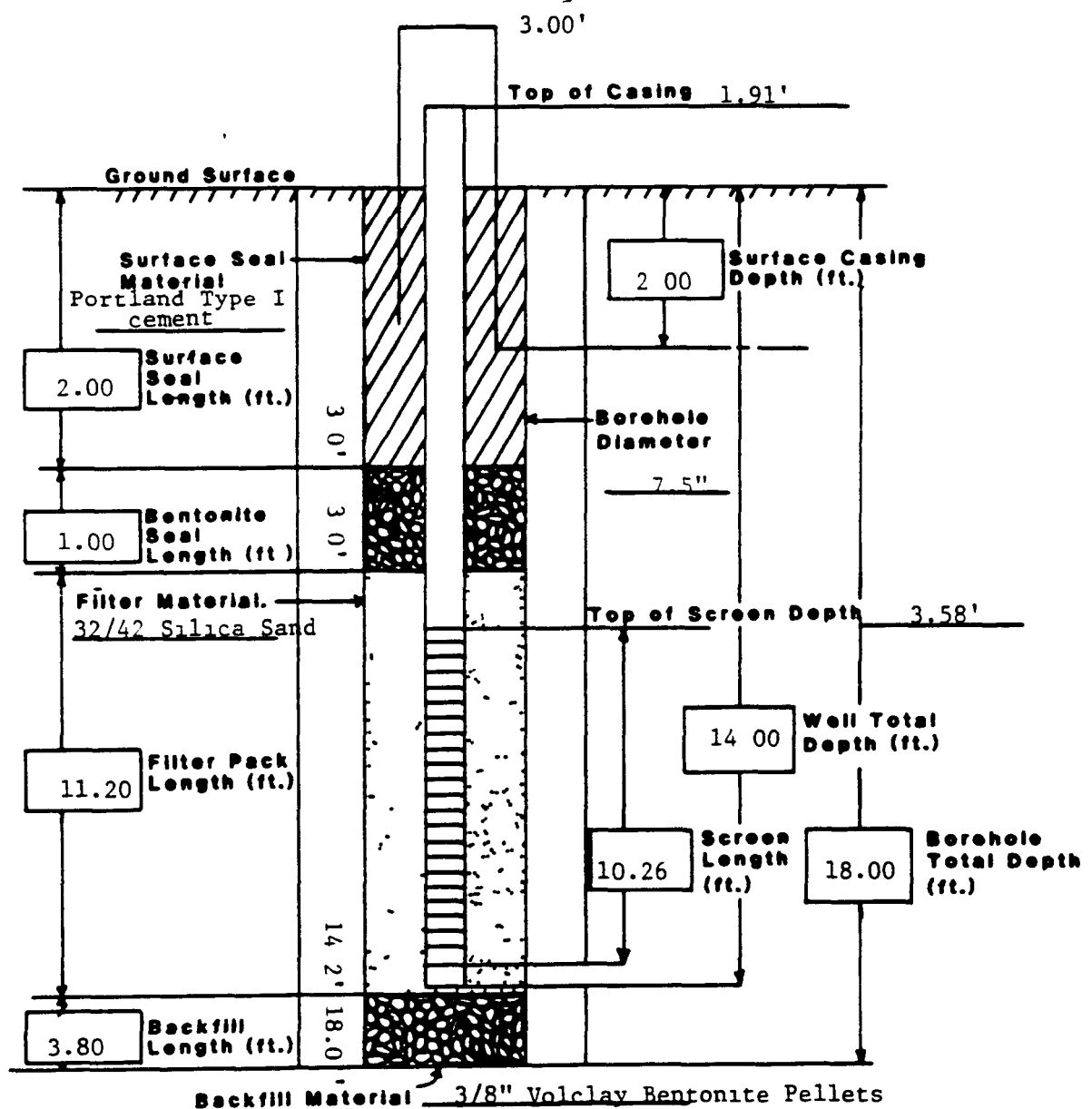
Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>140-160' SAMPLE</u> Recovered 20/20' = 100% CLAYSTONE dark gray (N 3/0), blocky, medium plastic, oxide stained in thin streaks, weathered, moist <u>160-180' SAMPLE</u> Recovered 20/20' = 100% CLAYSTONE same as above, weathered, moist TOTAL DEPTH 1800'	<u>140-160'</u> Bedrock sample BH628714BR <u>160-180'</u> Field screen readings HNu = 00 (00), OVA = 00 (00)

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, 881 Hillside Area Well No 51-87/BH62-87
 Coordinates N 35120.00 E 20738 10 Elevation Ground Surface 5963.30'
 Total Depth Well 14.08' Top of Casing 5965 21'
 Borehole 18.00'
 Formation of Completion Rocky Flats Alluvium
 Casing Material Sch 5, Type 316 TFJ stainless steel Casing Diameter 2" ID
 Screen Material 0.010" wire wrap Type 316 TFJ stainless steel Surface Casing Diameter 5" ID
 Date Installed October 22, 1987 Approved By _____
 Installed By R.T. Trear Site Manager
 Geologist _____
 CEARP Manager _____
 Comments _____



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Boring No 52-87/BH63-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
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- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

LOG
OF
BOREHOLE

Location Rocky Flats Plant, 881 Hillside Area Borehole/Well No 52-87/BH63-87
Coordinates N 35161.94 E 20954.54 Ground Surface Elevation 5967.57'
Total Depth 28.00' Water Level Encountered 15.2'
Static 5957.44' (2/4/88)
Drilling Company Boyles Bros. Driller S. Bradfield
Date Drilled October 16 & 19, 1987 Helper P. Mesa
Drilling Method Hollow Stem Auger Drilling Fluid None
Logged By R.T. Treat Checked By _____
Geologist Site Manager
CEARP Manager

Comments

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL</u>	
			<u>00-20' SAMPLE</u> Recovered 16/20' = 80% 00-14' CLAY varying browns, sandy to very sandy with gravel and noted roots, slightly calcareous, slightly moist	HNu background=02 OVA background=24 No Ludlum readings over background along core samples recovered
5			<u>ROCKY FLATS ALLUVIUM (DISTURBED)</u>	Field screen readings sample reading (field blank reading)
			14-16' CLAY grayish brown (5 YR 3/2) to dusky brown (5 YR 2/2), slightly sandy, moderately cemented, very stiff, low plastic, slightly moist	<u>00-16'</u> Field screen reading HNu = 00 (00), OVA = 00 (00)
10			<u>20-40' SAMPLE</u> Recovered 20/20' = 100% CLAY pale brown (5 YR 5/2) to light brown (5 YR 5/6), slightly sandy to very sandy (30-25 Ø), slightly calcareous streaked, moderately cemented, low plastic, moist	<u>20-40'</u> Field screen reading HNu = 00 (00), OVA = 00 (00)
15			<u>40-60' SAMPLE</u> Recovered 20/20' = 100% CLAY light brown (5 YR 5/6), low plastic, slightly sandy to sandy, fine-grained, weakly cemented, moist	<u>00-80'</u> Composite sample BH63870008 <u>40-60'</u> Field screen reading HNu = 00 (00), OVA = 00 (00)
20			<u>60-80' SAMPLE</u> Recovered 20/20' = 100% CLAY light brown (5 YR 5/6) to varying grayish brown, sandy (30-25 Ø) and fine-grained with scattered coarse sands, weakly cemented, low plastic, moist to very moist at bottom	<u>60-80'</u> Field screen reading HNu = 00 (00), OVA = 00 (00)

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 52-87/BH63-87
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Field _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>8.0-10.0' SAMPLE</u> Recovered 20/20' = 100% CLAY moderate yellowish brown (10 YR 5/4) to pale brown (5 YR 5/2), fine-grained sand (30-35 Ø up to 2.5-2.0 Ø), few scattered subangular and subrounded gravels 0.5 mm up to 2.5 mm, medium plastic, moderately cemented, moderately oxide (Fe) stained, moist	<u>8.0-10.0'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.0 (0.0)
25			<u>10.0-12.0' SAMPLE</u> Recovered 20/20' = 100% CLAY moderate yellowish brown (10 YR 5/4) to pale brown (5 YR 5/2), slightly sandy to sandy with small size scattered gravels, moderately to weakly cemented, moist	<u>10.0-12.0'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.0 (0.0)
30			<u>12.0-14.0' SAMPLE</u> Recovered 17/20' = 85% 12.0-12.2' CLAY same as above 12.2-13.7' CLAYEY SAND AND GRAVEL moderate brown (5 Y 4/4) to moderate yellowish brown (10 YR 5/4), fine-grained sand, well sorted, ranging from 3.0-2.5 Ø up to 0.5-1.0 Ø, gravel range 0.25 mm up to 3.75 mm, subangular with some subrounded, weakly cemented, very moist to moist	<u>12.0-13.7'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.6 (0.0) <u>12.0-13.7'</u> Sample taken BH638712DH
			<u>14.0-16.0' SAMPLE</u> Recovered 15/20' = 75% CLAYEY SAND AND GRAVEL moderate reddish brown (10 R 4/6) to a dark reddish brown (10 R 3/4), well graded sand and gravel ranging from 0.5 mm up to 2.75 mm, weakly cemented, moist to wet streak at 15.2-15.5'	<u>14.0-15.5'</u> Field screen reading HNu = 1.8 (2.1), OVA = 0.0 (0.0) <u>16.0-17.8'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.0 (0.0)

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 52-87/BH63-87
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>16.0-18.0' SAMPLE</u> Recovered 1 8/20' = 90% CLAYEY SAND AND GRAVEL same as above, moist	
			<u>18.0-20.0' SAMPLE</u> Recovered 0 4/20' = 20% SAND AND GRAVEL same as above	<u>18.0-18.4'</u> Upper contact sample BH638718UC
			<u>ARAPAHOE FORMATION</u>	HNu background=0 4 OVA background=3 4 No Ludlum readings above background along core sample recovered
			<u>20.0-22.0' SAMPLE</u> No recovery CUTTINGS weathered claystone	<u>22.0-22.5'</u> Contact sample taken BH638722CT
			<u>22.0-23.0' SAMPLE</u> Recovered 0 5/10' = 50% WEATHERED CLAYSTONE disturbed sample recovery	<u>24.5-26.0'</u> Bedrock sample BH638724BR
			<u>23.0-24.0' SAMPLE</u> No recovery	<u>26.0-28.0'</u> Field screen readings HNu = 0 0 (0.0), OVA = 0 0 (0.0)
			<u>24.0-24.5' SAMPLE</u> No recovery Drilled with center bit	
			<u>24.5-26.0' SAMPLE</u> Recovered 1 5/15' = 100% WEATHERED CLAYSTONE medium dark gray (N 4/0), massive, blocky, medium to highly plastic, moist	

LOG
OF
BOREHOLE

Location _____

Coordinates _____

Total Depth _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By

Geologist

Borehole/Well No 52-87/BH63-87

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

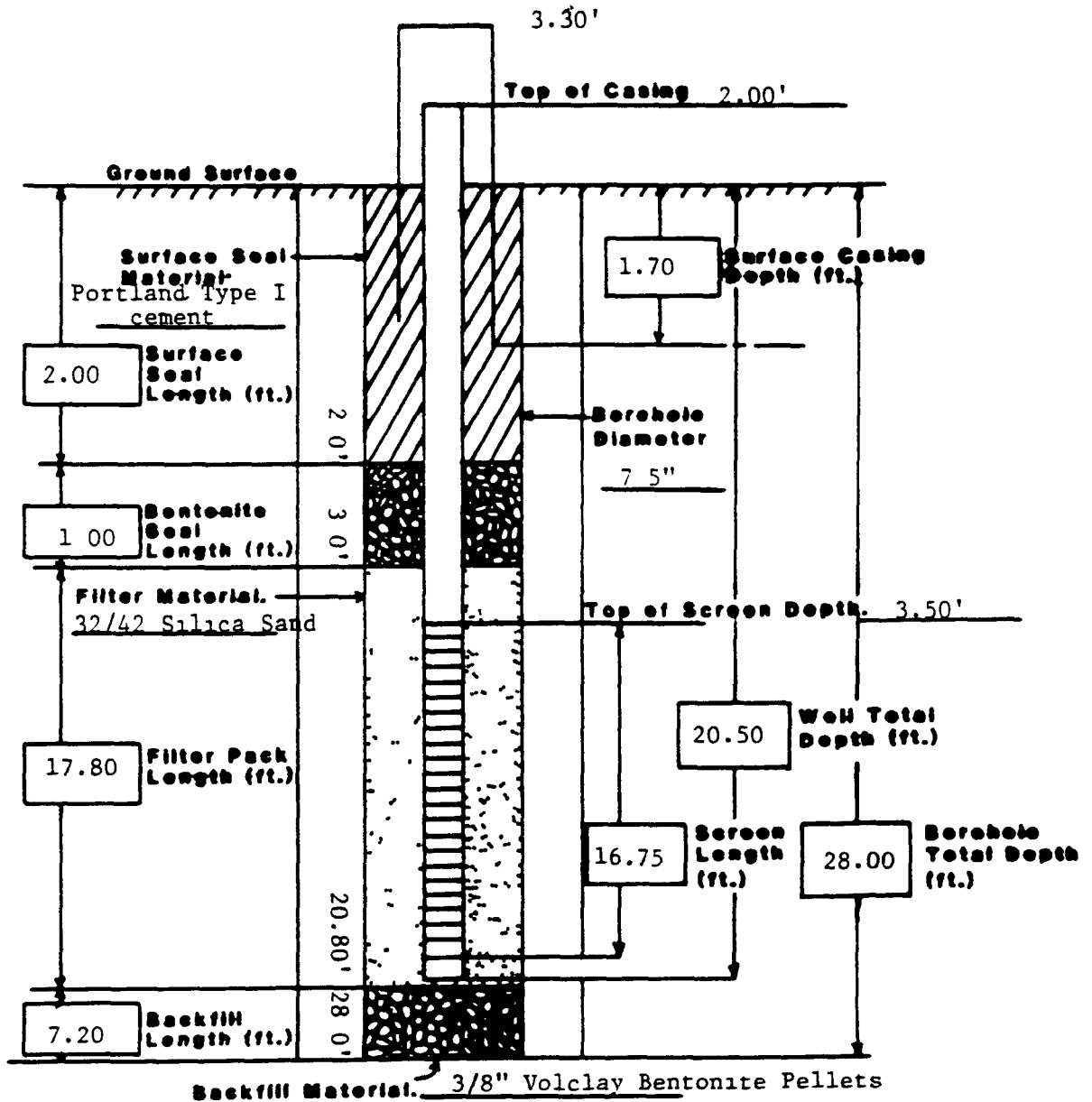
Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>26.0-28.0' SAMPLE</u></p> <p>Recovered 20/20' = 100%</p> <p>WEATHERED CLAYSTONE medium dark gray (N 4/0) to medium light gray (N 6/0), slightly oxide stained, massive, blocky, moist</p> <p>TOTAL DEPTH 28.00'</p>	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, 881 Hillside Area Well No 52-87/BH63-87
 Coordinates N 35161 94 E 20954.54 Elevation Ground Surface 5967.57'
 Total Depth Well 20.50' Top of Casing 5969.57'
 Borehole 28.00'
 Formation of Completion Colluvium
 Casing Material Sch 5, Type 316 TFJ stainless steel Casing Diameter 2" ID
 Screen Material 0.010" wire wrap 316 TFJ Surface Casing Diameter 5" ID
 Date Installed October 20, 1987 stainless steel Approved By _____
 Installed By R T Treat Site Manager
 Geologist _____

Project Director

Comments _____



INDEX OF DATA

Boring No 53-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

LOG OF BOREHOLE

Location Rocky Flats Plant, 881 Hillside Area

Coordinates N 35002 12 E 20799 61

Total Depth 14 00'

Drilling Company Bovles Bros

Date Drilled October 12 & 13, 1987

Drilling Method Hollow Stem Auger

Logged By R T. Treat
Geologist

Borehole/Well No 53-87

Ground Surface Elevation 5959 82'

Water Level Encountered None

Static 6046.93' (2/24/88)

Driller S Bradfield

Helper P Mesa

Drilling Fluid None

Checked By _____
Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			ARTIFICIAL FILL	
			<u>00-2.0' SAMPLE</u> Recovered 1 7/20' = 85%	
5			00-15' CLAY AND SAND gravish brown (5 YR 3/2) to light olive gray (5 Y 5/2), silty sands in upper formation to rounded and subrounded scattered gravel (150 mm to 325 mm) weakly to moderately cemented, low plastic, moist	HNu background=0.4 OVA background=0.2 Ludlum readings taken indicating 0.0 readings
			COLLUVIUM (DISTURBED)	
10			15-17' CLAYEY SAND subrounded and subangular gravel up to 250 mm, medium- and coarse-grained sand (20-15 Ø to 0.5-0.0 Ø), weakly cemented, well sorted sand and poorly sorted gravel, light moist	00-1.7' No readings over background along core sample
			<u>20-40' SAMPLE</u> Recovered 0 8/20' = 40%	2.0-2.81' Readings along core OVA = 3.2, HNu = 0.0
15			CLAY light brown (5 YR 5/6) to light olive gray (5 Y 5/2), some oxide staining, fine-grained sand (30-25 Ø), scattered subrounded and subangular gravel (0.5 mm up to 2.5 mm) of quartzite composition, low to medium plastic, fill, moist	No readings in breathing zone
				4.0-5.5' No readings over background along core

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 53-87
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>40-60' SAMPLE</u> Recovered 15/20' = 75% CLAY AND GRAVEL dusky yellowish brown (10 YR 2/2) to moderate reddish brown (10 R 4/6), angular, subangular, and subrounded gravel up to 550 mm, medium- to coarse-grained sand (10-05 Ø), some coarser-grained sand, low plastic, moderately to weakly cemented, at 40-43', zone of organic clay, moist to light moist	
			<u>60-80' SAMPLE</u> Recovered 20/20' = 100% CLAY moderate yellowish brown (10 YR 5/4) to pale brown (5 YR 5/2), medium plastic, slightly sandy, angular and subangular gravel (0.02 mm up to 150 mm), moderately cemented, moist	<u>60-80'</u> No reading over background along core
			<u>80-100' SAMPLE</u> Recovered 20/20' = 100% 80-88' CLAY WITH SCATTERED GRAVEL same as above	<u>80-100'</u> No readings over background along core
			<u>ARAPAHOE FORMATION</u> 88-100' WEATHERED CLAYSTONE medium light gray (N 6/0) to medium gray (N 5/0), massive, blocky, slightly calcareous, somewhat oxide (Fe) stained, medium plastic, moist	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 53-87
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>100-120' SAMPLE</u> Recovered 20/20' = 100% WEATHERED CLAYSTONE medium light gray (N 6/0), massive, blocky, medium plastic, slightly calcareous pock- ets noted at 115', very slightly oxide stained, moist	<u>100-120'</u> No readings over background along core
			<u>120-140' SAMPLE</u> Recovered 20/20' = 100% WEATHERED CLAYSTONE medium light gray (N 6/0), massive, blocky, medium plastic, moderately oxide stained at 138', noted lignite streaks at 130', moist	<u>120-140'</u> No readings over background along core
			TOTAL DEPTH 1400'	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, 881 Hillside Area

Well No 53-87

Coordinates N 35002 12 E 20799 61

Elevation Ground Surface 5959 82'

Total Depth Well 9 30'

Top of Casing 5961 84'

Borehole 14 00'

Formation of Completion Colluvium

Casing Material Sch 5, Type 316 TFJ stainless steel

Casing Diameter 2" ID

Screen Material 0 010" wire wrap Type 316 TFJ stainless steel

Surface Casing Diameter 5" ID

Date Installed October 13, 1987

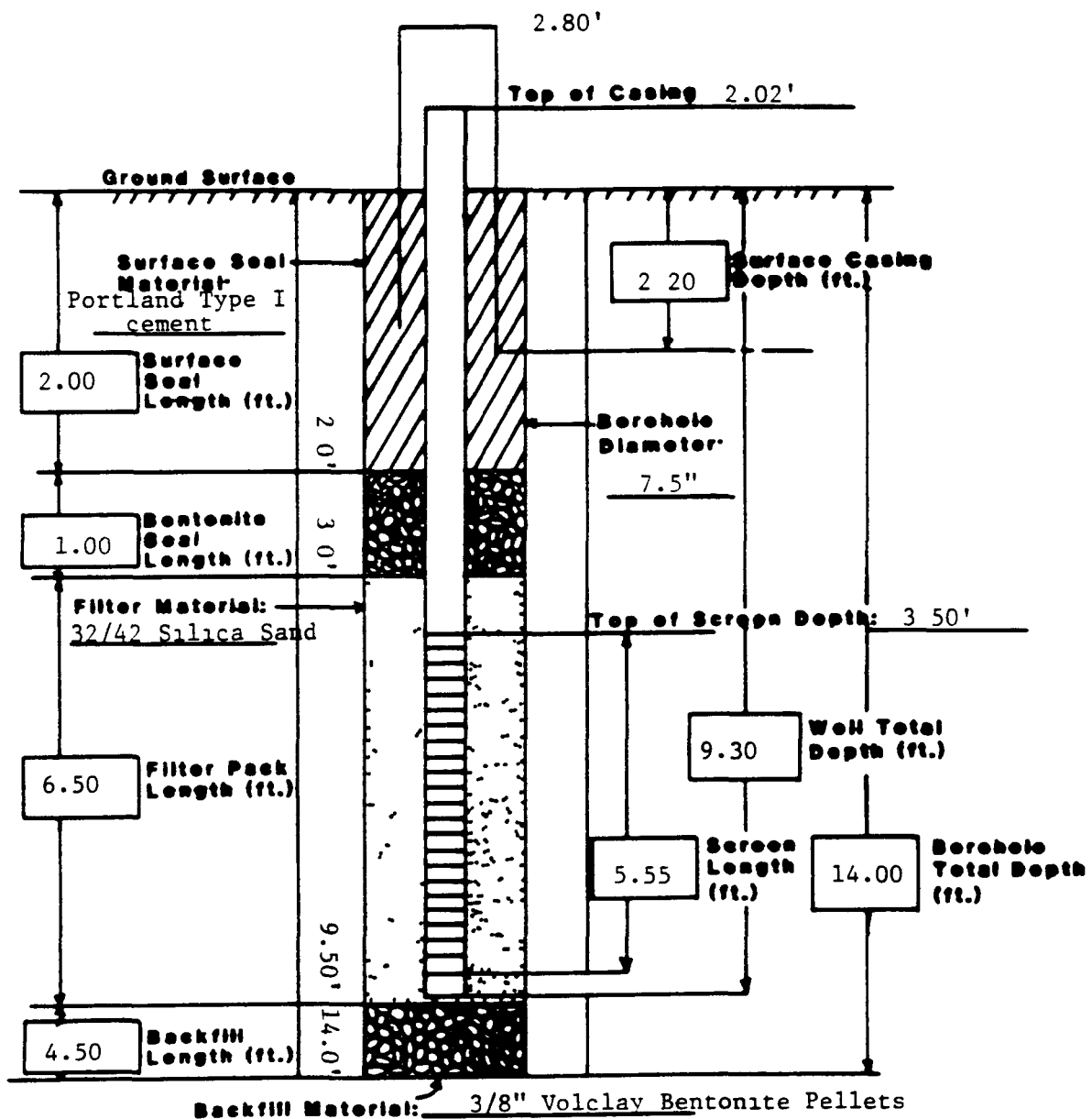
Approved By _____

Installed By R.T. Trear
Geologist

Site Manager

Project Director

Comments _____



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Boring No 54-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

LOG OF BOREHOLE

Location Rocky Flats Plant; 881 Hillside Area Borehole/Well No 54-87
 Coordinates N 35001 45 E 20919 36 Ground Surface Elevation 5955.85'
 Total Depth 10.00' Water Level Encountered None
 Static 5954 49' (2/4/88)
 Drilling Company Boyles Bros. Driller S. Bradfield
 Date Drilled October 13, 1987 Helper P. Mesa
 Drilling Method Hollow Stem Auger Drilling Fluid None
 Logged By R.T. Treat Checked By Site Manager
 Geologist CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			ARTIFICIAL FILL	
			<u>00-2.0' SAMPLE</u> Recovered 18/20' = 90%	HNu background=00 OVA background=00
			00-0.7' CLAY AND GRAVEL grayish orange (10 YR 7/4), roots noted, slightly sandy, weakly cemented, very calcareous, light moist	Ludlum readings taken
5			0.7-1.8' CLAY medium gray (N 5/0), blocky, moderately oxide stained, few scattered roots noted, moist	No readings above background on core or in breathing zone
			<u>2.0-4.0' SAMPLE</u> Recovered 20/20' = 100%	No readings above background
			2.0-3.2' CLAY moderate yellowish brown (10 YR 5/4), fill, low plastic, mod- erately cemented, slightly sandy with medium-grained sands (10-0.5Ø)	
10			COLLUVIUM (DISTURBED)	
			3.2-4.0' CLAY dark yellowish orange (10 YR 6/6) to pale yellowish brown (10 YR 6/2), slightly sandy to very sandy, fine-grained (2.0-1.5Ø), low plastic, mod- erately cemented, severely oxide (Fe) stained, moist	
			<u>4.0-6.0' SAMPLE</u> Recovered 20/20' = 100%	
			4.0-4.2' CLAY same as above, transition into a weathered claystone	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 54-87
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>ARAPAHOE FORMATION</u>	
			42-60' WEATHERED CLAYSTONE pale brown (5 Y 3/2) to a light gray (N 7/0), sandy to very sandy at 47-52', fine-grained sand (2.5-2.0Ø), slightly calcareous, severely oxide stained, medium to low plastic, blocky, slightly porous with noted few roots, moist	
			<u>60-80' SAMPLE</u> Recovered 20/20' = 100% WEATHERED CLAYSTONE medium light gray (N 6/0) varying with olive grays, slightly oxide stained, few roots still noted, slightly sandy, fine-grained, blocky, medium to low plastic, moist	
			<u>80-100' SAMPLE</u> Recovered 20/20' = 100% WEATHERED CLAYSTONE same as above, moist	
			TOTAL DEPTH 1000'	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, 881 Hillside Area

Well No 54-87

Coordinates N 35001.45 E 20919.36

Elevation Ground Surface 5955.85'

Total Depth Well 4.68'

Top of Casing 5957.72'

Borehole 10.00'

Formation of Completion Colluvium

Casing Material Sch 5, Type 316 TEJ stainless steel

Casing Diameter 2" ID

Screen Material 0.010" wire wrap Type 316 TEJ stainless steel

Surface Casing Diameter 5" ID

Date Installed October 15, 1987

Approved By _____

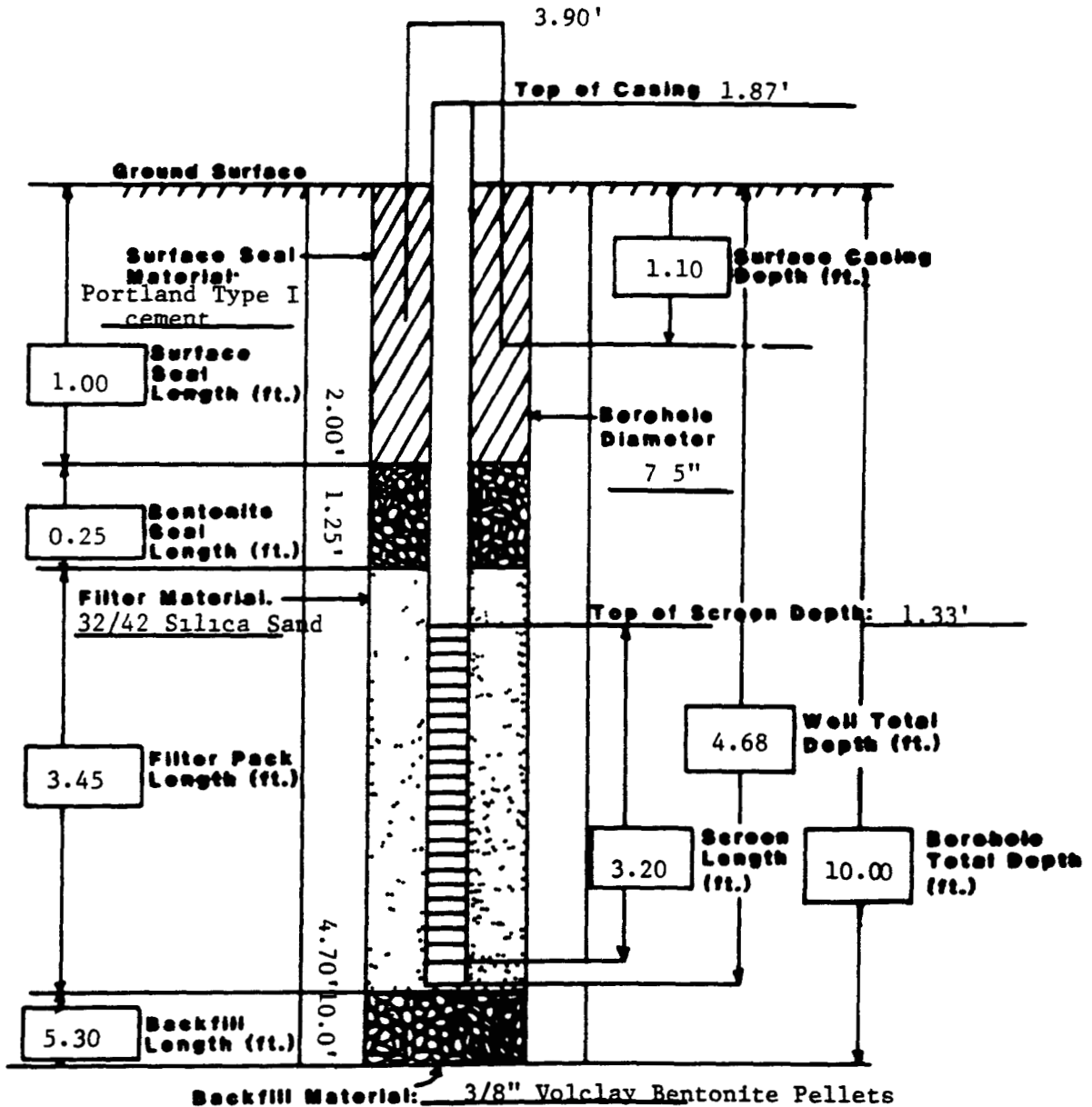
Installed By R.T. Treat

Site Manager _____

Geologist

Project Director _____

Comments _____



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Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
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- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Pond Area
Coordinates N 37654.23 E 21319 10
Total Depth 13 40'

Borehole/Well No 56-87/SP16-87
Ground Surface Elevation 5978 51'
Water Level Encountered None
Static 5973 19' (4/18/88)

Drilling Company Boyles Bros
Date Drilled January 7, 1988
Drilling Method Hollow Stem Auger
Logged By KD Hollaway
Geologist

Driller T High
Helper B Keeney
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>TOP SOIL</u>	
			<u>00-20 SAMPLE</u> Recovered 20/20 = 100%	HNu background=12 OVA Background=16 Ludlum background = 00
			00-05 TOP SOIL varied greens and browns grass and ice subangular cobbles up to 1" diameter, sandy clay, frozen	<u>00-20</u> Field screen readings HNu = 12 (12), OVA = 19 (12)
5			<u>ARTIFICIAL FILL/DISTURBED</u>	<u>00-20'</u> Field screen sample SP168702FS
			05-11' CLAYEY SAND pale yellowish brown (10 YR 6/2) to dark yellowish brown (10 YR 4/2), very coarse-grained (20-15 Ø to 1/4") poorly sorted sand subrounded to angular small quartzite gravel up to 1" diameter, unconsolidated, moist to frozen	<u>20-35</u> Field screen readings HNu = 12 (12), OVA = 12 (12)
10			11-20 SANDY CLAY moderate brown (5 YR 3/4) some very coarse-grained poorly sorted subrounded to angular sand angular quartzite gravel up to 3" diameter varied green to yellow red orange to red staining throughout core, damp	<u>40-60</u> Field screen readings HNu = 16 (16), OVA = 12 (12) <u>60-80</u> Field screen readings HNu = 12 (12), OVA = 10 (10)
15				<u>60-80</u> Upper con- tact sample SP168708UC
				<u>100-112</u> Contact sample SP168710CT
20				<u>112-134</u> Field screen readings HNu = 12 (12), OVA = 10 (10)

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Pond Area
 Coordinates N 37654 23 E 21319 10
 Total Depth 13.40'

Borehole/Well No 56-87/SP16-87 (cont'd.)
 Ground Surface Elevation 5978 51'
 Water Level Encountered None
 Static 5973.19' (4/18/88)

Drilling Company Boyles Bros
 Date Drilled January 7, 1988
 Drilling Method Hollow Stem Auger
 Logged By KD Holliday
 Geologist

Driller T High
 Helper B. Keenev
 Drilling Fluid None
 Checked By _____
 Site Manager
 CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>20-40 SAMPLE</u> Recovered 15/20' = 75% CLAYEY SAND AND GRAVEL light brown (5 YR 5/6) with pale yellowish orange (10 YR 8/6) and dark yellowish orange (10 YR 6/6) with trace moderate reddish brown (10 YR 4/6), mostly in sand zones very coarse-grained, poorly sorted sand subangular to angular quartzite gravel subangular to broken to 3" diameter, becomes sandier down core with medium-grained (2.5-1.5 Ø) fairly sorted subangular sand damp	<u>11.2-13.4 Bedrock</u> Sample SP168711BR
			<u>40-60 SAMPLE</u> Recovered 20/20' = 100% SANDY CLAY moderate yellowish brown (10 YR 5/4) to dark yellowish brown (10 YR 4/2) with some yellowish gray (5 Y 7/2) especially towards bottom of core subangular to angular quartzite gravel up to 2" diameter increases down core quartzitic sand and pebbles, sub-rounded to subangular medium-grained (2.0-1.5 Ø) to coarse-grained up to 1/4" diameter poorly sorted, unconsolidated, some caliche increases down core, damp to moist	

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Pond Area
 Coordinates N 37654 23 E 21319.10
 Total Depth 13.40'

Borehole/Well No 56-87/SP16-87 (cont'd.)
 Ground Surface Elevation 5978 51'
 Water Level Encountered None
 Static 5973 19' (4/18/88)

Drilling Company Boyles Bros
 Date Drilled January 7, 1988
 Drilling Method Hollow Stem Auger
 Logged By KD Holliday
 Geologist

Driller T High
 Helper B Keeney
 Drilling Fluid None
 Checked By _____
 Site Manager
 CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>60-80' SAMPLE</u> Recovered 20/20' = 100% 60-63 GRAVEL angular to broken some fine-grained sand dry 63-70' CLAYEY SAND dusky yellow (5 Y 6/4) to yellowish gray (5 Y 7/2), some clay, sand is very fine-grained to fine- grained (25-20 Ø) fairly well sorted, unconsolidated some caliche (strong reaction to HCl), damp to moist 700-800 CLAYEY SAND AND GRAVEL yellowish gray (5 Y 7/2) with light brown (5 YR 5/6) and moderate reddish brown (10 R 4/6) staining fine- grained (25-20 Ø) to coarse-grained poorly sorted subrounded to subangular sand subangular gravel lots of caliche unconsolidated moist	
			<u>80-100 SAMPLE</u> Recovered 00/20' = 0% Lost core	
			<u>ARAPAHOE FORMATION</u> O/Ka contact estimated at 940 by drilling and cuttings	
			<u>100-112 SAMPLE</u> Recovered 18/12 = 150% SANDY CLAYSTONE light olive gray (5 Y 5/2) to yellowish gray (5 Y 7/2) with dark yellowish orange (10 YR 6/6) iron staining, very fine-grained to fine- grained sand, some caliche consolidated damp	

LOG
OF
BOREHOLE

Location Rocky Flats Plant, Solar Pond Area

Coordinates N 37654 23 E 21319 10

Total Depth 13.40'

Drilling Company Bovles Bros

Date Drilled January 7, 1988

Drilling Method Hollow Stem Auger

Logged By KD Hollaway
Geologist

Borehole/Well No 56-87/SP16-87 (cont'd.)

Ground Surface Elevation 5978.51'

Water Level Encountered None

Static 5973.19' (4/18/88)

Driller T High

Helper B. Keeney

Drilling Fluid None

Checked By _____ Site Manager

CEARP Manager

Comments

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>112-134' SAMPLE.</u> Recovered 22/22 = 100% SANDY CLAYSTONE same as above with occasional iron nodules</p> <p>TOTAL DEPTH 1340'</p>	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, Solar Ponds Area

Well No 56-87/SP16-87

Coordinates N 37654.23 E 21319.10

Elevation Ground Surface 5978.51'

Total Depth Well 9.92'

Top of Casing 5979.89'

Borehole 13.40'

Formation of Completion Rocky Flats Alluvium

Casing Material Sch 5, Type 316, TFJ Stainless Steel

Casing Diameter 2" ID

Screen Material 0.010" wire wrap, Type 316, TFJ Stainless Steel

Surface Casing Diameter 5" ID

Date Installed January 8, 1987

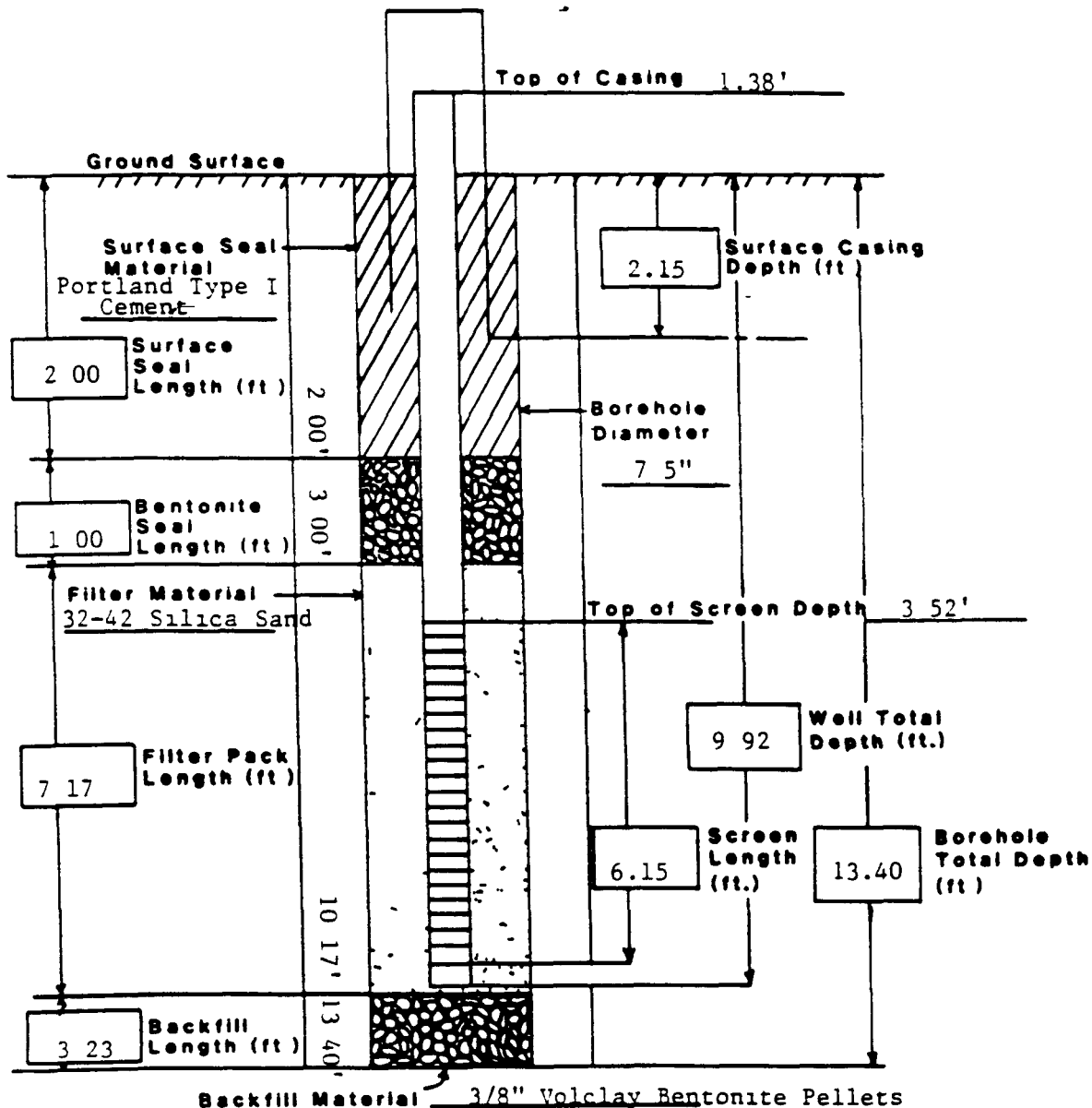
Approved By _____

Installed By K D Hollaway
Geologist

Site Manager

CEARP Manager

Comments _____



1987 BOREHOLES

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Boring No SP01-87

Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area
 Coordinates * N 37792 E 21209
 Total Depth 30.2'

Borehole/Well No SP01-87
 Ground Surface Elevation *5982.7'
 Water Level Encountered 15.2'

Drilling Company Boyles Bros.
 Date Drilled October 27-28, 1987
 Drilling Method Hollow Stem Auger
 Logged By J. Bacchus
 Geologist

Static _____
 Driller R. Sharp
 Helper T. Merritt
 Drilling Fluid None
 Checked By _____
 Site Manager
 CEARP Manager

Comments Borehole backfilled with Portland Type I Cement
*Coordinates and elevation estimated from topographic map.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
			0 0-2.0' SAMPLE Recovered 1.2/2.0' = 60%.	HNu Background=0.8 OVA Background=1.0 Ludlum Background=0 0
			0-0 6' SAND moderate yellowish brown (10 YR 5/4), silt and clay, asphalt, slight HCl reaction.	
			0.6-1.2' CLAY moderate yellowish brown (10 YR 5/4); dense, large pebbles, caliche, dry	No Ludlum readings above background
			2.0-4 0' SAMPLE Recovered 2 0/2.0' = 100%.	0 0-1.2': Field Screen Reading HNu=0.4(0 4), OVA=1.2(0.6)
5			CLAY: dense; large angular clasts of igneous origin, reacts with HCl, slightly moist	0 0-1.2' Field Screen Sample. SP018700FS
			4 0-5.0' SAMPLE Recovered 1.2/1 0' = 120%	4 0-5 0' Reading on Core HNu=1 4, OVA=1.2
			4 0-4 1' CLAY same as above	4 0 5 0' Direct Hit Sample SP018704DH
			4 1-4.35' layer of asphalt	5 0-6.3': Reading on Core HNu=3.4, OVA=1.2
			4.35-5 0' CLAY same as layer above except one large chunk of redwood, appears to be a stake	5 0-6.3' Direct Hit Sample SP018705DH.
			5 0-8.0' SAMPLE Recovered 1.3/3.0' = 43%	8 0-10.0': Readings on Core: HNu=3.4, OVA=1.2
10			5.0-7 7' CLAY moderate yellowish brown (10 YR 5/4) with some spots of dark yellowish orange (10 YR 6/6), sandy, silty, pebbly, clasts are subangular to highly angular; dry	10.5' Readings in Breathing Zone. HNu=0 6, OVA=2.5.
			7 7 8.0'. CLAY moderate reddish brown (10 YR 4/6), some coarse sand, slightly moist	10 5-12.2' Readings on Core HNu=1 0, OVA=2 8
			8 0-10.5' SAMPLE Recovered 2.0/2.5' = 80%.	10.5-12.2' Direct Hit/Upper Contact Sample SP 018711DH
			8 0-9.1'. CLAY same as above	12.7-13 9' Readings on Core HNu=1 0, OVA=2.8
			9 1-10.0' SAND moderate yellowish brown (10 YR 5/4) to dark yellowish orange (10 YR 6/6); no HCl reaction; very poorly sorted, size ranges from clay to pebbles, clasts are very angular; dry	
15			10 5-12 7' SAMPLE. Recovered 1.65/2 5' = 66%	
			SAND same as above, contains some subrounded small cobbles; dry	
			12 7-15 2' SAMPLE Recovered 1 2/2 5' = 48%	
			12 7 13.2' SAND moderate reddish brown (10 YR 4/6), conglomeratic sand, poorly sorted, silt, clay and large pebbles angular to subrounded, sand, slight HCl reaction; dry	
20				

LOG OF BOREHOLE

Location Rocky Flats Plant; Solar Ponds Area

Borehole/Well No. SP01-87(cont'd)

Coordinates _____

Ground Surface Elevation _____

Total Depth _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>ARAPAHOE FORMATION</u>	
			13.2-13.9' SANDSTONE yellowish gray (5 Y 7/2); clean; mottled oxidation; dark yellowish orange (10 YR 6/6), well sorted, small amount of clay, slightly moist	12.7-14.9' Direct Hit/Contact Sample SP018713DH.
			15.2-17.7' SAMPLE. Recovered 1.5/2.5' = 60%.	15.2-16.7' Readings on Core HNU=2 1, OVA=10.0
			SANDSTONE: moderate yellowish brown (10 YR 5/4) to yellowish gray (5 Y 7/2), claystone soaked except last 0.15 ft where it is wet to moist	15.2-16.7' Bedrock Sample SP018716BR
25			17.7-20.2' SAMPLE. Recovered 2.35/2.5' = 94%	20.2-22.3' Readings on Core. HNU=2 3; OVA=1.8
			17.7-17.9' CLAYSTONE light olive gray (5 Y 5/2), very fissile, no sand, moist	20.2-22.3'. Direct Hit Sample SP018721DH
			17.9-18.9' SANDSTONE alternating bands of yellowish gray (5 Y 7/2) and dark yellowish orange (10 YR 6/6); coarse-grained, subrounded, moist to dry	22.7-24.8' Readings on Core HNU=0 2; OVA=4.3
			18.9-20.05' SANDSTONE yellowish gray (5 Y 7/2), highly stained with dark yellowish orange (10 YR 6/6), fractures; well consolidated, fine to coarse-grained; no HCl reaction; moist	22.7-24.8' Direct Hit Sample SP018723DH
30			20.2-22.7' SAMPLE Recovered 2.1/2.5' = 84%	25.2-27.6' Readings on Core HNU = 0.3, OVA = 0.6
			SANDSTONE: same as above	27.7-30.2' Readings on Core: HNU = 0.3; OVA = 0.6
			22.7-25.2' SAMPLE. Recovered 2.1/2.5' = 84%.	
			SANDSTONE: dark yellowish orange (10 YR 6/6) and yellowish gray (5 Y 7/2); fine-grained, well consolidated, slightly moist	
35			25.2-27.7' SAMPLE. Recovered 2.4/2.5' = 96%	
			25.2-25.9' CLAYSTONE dark yellowish orange (10 YR 6/6) and yellowish gray (5 Y 7/2), sand, dry	
			25.9-27.6': SANDSTONE dark yellowish orange (10 YR 6/6) and yellowish gray (5 Y 7/2), coarse-grained; dry	
			27.7-30.2' SAMPLE. Recovered 2.65/2.5' = 120%	
			SANDSTONE: same as above except sand is finer-grained	
			TOTAL DEPTH: 30.2'	
40				

INDEX OF DATA

Boring No SP02-87

Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates * N 37980 E 21532

Total Depth 15.1'

Borehole/Well No SP02-87

Ground Surface Elevation *5976.6'

Water Level Encountered None

Static

Drilling Company Boyles Bros.

Driller R. Sharp

Date Drilled October 29, 1987

Helper T. Merritt

Drilling Method Hollow Stem Auger

Drilling Fluid None

Logged By J. Bacchus

Checked By

Geologist

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement.

*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
			0-2.0' SAMPLE. Recovered 2.0/2.0' = 100%. CLAY grayish brown (5 YR 3.2), sand, silt and gravel, clasts are angular, no roots, well indurated; dry.	HNu Background=0.9 OVA Background = 0.5-5.0 Ludlum Background = 0.0
			2.0-4.0' SAMPLE Recovered 1.7/2.0' = 81%. CLAY grayish brown (5 YR 3/2); poorly sorted, with sand silt and gravel; no reaction with HCl, dry	No readings above background
5			4.0-7.0' SAMPLE. Recovered 1.7/3.0' = 53% CLAY same as above	0.0-10.1' Composite Sample: SP02870008 (VOAs taken at 7.6-10.1).
			Total depth measured at 7.6' Readjust depth	7.6-10.1' Upper Contact Sample: SP028708UC
10			7.6-10.1' SAMPLE. Recovered 2.7/2.5' = 108% 7.6-7.85' CLAY same as above 7.85-9.0' CALICHE: very pale orange (10 YR 8/2), reacts violently with HCl; silt size, dry. 9.0-10.1' CLAY: pale yellowish orange (10 YR 8/6), caliche; reacts violently with HCl, some angular pebbles; sand and silt, dry	10.1-12.6' Contact Sample SP028711CT
			<u>ARAPAHOE FORMATION</u>	12.6-15.1' Bedrock sample. SP028713BR
15			10.1-12.6' SAMPLE. Recovered 2.6/2.5' = 104% SANDSTONE yellowish gray (5 Y 7/2) with bands of light yellowish orange, fine to coarse-grained sand; caliche; coal; turns green with contact with HCl, dry.	
			12.6-15.1' SAMPLE Recovered 2.7/2.5' = 108% SANDSTONE. same as above except mottled with light yellowish orange, the sand is coarser, slightly moist near the bottom	
			TOTAL DEPTH: 15.1'	
20				

INDEX OF DATA

Boring No SP03-87

Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates * N 37485 E 21532

Total Depth 20.4'

Borehole/Well No SP03-87

Ground Surface Elevation *5978 7'

Water Level Encountered 12 8'

Static

Drilling Company Bovles Bros

Driller R Sharp

Date Drilled October 21 and 26, 1987

Helper T Merritt

Drilling Method Hollow Stem Auger

Drilling Fluid None

Logged By J. Bacchus

Geologist

Checked By

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement.

*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
		<u>0 2 0' SAMPLE</u>	Recovered 1 75/2 0' = 86% SOIL dark yellowish brown (10 YR 4/2), roots in the upper 0 4 ft, sizes range from clay to small cobbles, clasts are very angular and not oriented in any order, very poorly sorted, dry	HNu Background=0 4 OVA Background = 0 0 2 2 Ludlum Background = 0 0
			<u>ROCKY FLATS ALLUVIUM</u>	
		<u>2 0-4 0' SAMPLE</u>	Recovered 1 5/2 0' = 75% 2 0 3 1' CLAY same as above 3 1-3.5' CLAY same as above except much more clay, grayish black (N 2/0), moist	2 0-3 5' Reading on Core HNu=2 0, OVA=20
5				2 0 3 5' Direct Hit Sample SP038702DH
		<u>4 0 5 0' SAMPLE</u>	Recovered 0 6/1 0' = 60% CLAY. same as above except a large quartzite cobble	4 0' Reading in Augers HNu=4, OVA=39
				4 0 4 6' Field Screen Sample SP038703FS (VOAs only)
10		<u>5 0 8 0' SAMPLE</u>	Recovered 1 85/3.0' = 62% 5 0-5 7' CLAY dusky red (5 R 3/4), some sand, pebbles to 2 5" diameter, clasts range from rounded to angular, moist 5 7-6 85' SAND moderate yellowish brown (10 YR 5/4), small cobbles and clay clasts range from rounded to angular, no HCl reaction	10 3 11 6' Readings on Core HNu=0 3, OVA=3 6
				10 3 11 6' Direct Hit/Upper Contact Sample SP038711DH
		<u>8 0 10 5' SAMPLE</u>	Recovered 1 1/2 5' = 44% SAND moderate yellowish brown (10 YR 5/4), mottled with very pale orange (10 YR 8/2), silty sand, large quartzite clasts that are subrounded to angular, high amount of caliche, very poorly sorted, dry	12 8-14 4' Readings on Core HNu=0 3, OVA=2 6
15		<u>10 5 12 8' SAMPLE</u>	Recovered 1 3/2 5' = 52% SAND moderate yellowish brown (10 YR 5/4), poorly sorted, quartzite clasts that range in size from small cobbles to large pebbles, some silt, very little clay, no HCl reaction	
20				

LOG
OF
BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates _____

Total Depth _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By

Geologist

Borehole/Well No SP03-87(cont'd.)

Ground Surface Elevation _____

Water Level Encountered _____

Static

Driller

Helper _____


Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<p><u>12 8-15.2' SAMPLE.</u> Recovered 1 6/2 5' = 64% 12 8 13 2' GRAVEL moderate yellowish brown (10 YR 5/4), very poorly sorted, clasts are highly angular, clay, silt and sand, saturated, encountered water table at the top of the run</p> <p><u>ARAPAHOE FORMATION</u></p> <p>13 2-14 4' CLAYSTONE light olive gray (5 YR 3/2), mottled light brown (5 YR 5/6), dense, pockets of caliche, semi-moist to dry</p> <p><u>15 2-17 7' SAMPLE</u> Recovered 1 7/2 5' = 68% CLAYSTONE same as above except getting sandy near the bottom of the run</p> <p>Total depth with plopper 17 9' Adjust depth</p> <p><u>17 9-20 4' SAMPLE</u> Recovered 1 8/2.5' = 72% 17 9-18 0' CLAYSTONE light olive gray (5 Y 5/2), stained light brown (5 YR 5/6), dense, no HCl reaction, moist to wet 18 0-19 7' SILTSTONE dark yellowish orange (10 YR 6/6), some coarse-grained sand clasts, pockets of caliche, dry</p> <p>TOTAL DEPTH 20 4'</p>	<p><u>12 8 14 4' Contact</u> Sample SP038713CT</p> <p><u>15 2 16 9' Readings on</u> Core HNU=0 4, OVA=5 2</p> <p><u>15 2 16 9' Bedrock</u> Sample SP0387168R</p> <p><u>17 9-19 7' Readings on</u> Core HNU=0 3, OVA=2 6</p>
25				
30				
35				
40				

INDEX OF DATA

Boring No SP04-87

Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdriograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area
Coordinates * N 37561 E 21820
Total Depth 37 0'

Borehole/Well No SP04-87
Ground Surface Elevation *5971.8'
Water Level Encountered 12.0'

Static _____

Drilling Company Boyles Bros
Date Drilled October 30 and November 3 and 4,
Drilling Method Hollow Stem Auger 1987
Logged By J. Bacchus
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement
*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
		0 0 2.0' SAMPLE	Recovered 1 2/2.0' = 60%	HNu Background = 0 4-0 5 OVA Background = 0 6-3 6 No Ludlum readings taken
		0 0 0 3' PEBBLE large		
		0 3 0 9' CLAY moderate yellowish brown (10 YR 5/4), sand, silt and pebbles, clasts are angular to subrounded, slight reaction to HCl, moist		2 0-3 7' Readings on Core HNu = 15, OVA = 0 4
		0 9 1 2' IGNEOUS ROCK some fractures		2 0 3 7' Direct Hit Sample SP048702DH
5		2 0-4 0' SAMPLE	Recovered 1 7/2 0' = 85%	4 0-5 8' Reading on Core HNu=400, OVA=0 2
		GRAVEL dusky brown (5 YR 2/2), cobbles to 4 inches in diameter, held together with clay, no HCl reaction; moist		4 0 5 8' Direct Hit Sample SP048704DH
		4.0-7 0' SAMPLE	Recovered 1 8/3 0' = 60%	4 0 5 8' Duplicate Sample SP0487004D
		4 0-4 8' GRAVEL same as above		
		4 8 5 8' CALICHE, very pale orange (10 YR 8/2), silt, small angular cobbles similar to the clasts above; dry		7 0' Readings in Breathing Zone HNu=1 2, OVA=1 0
10		7 0-9 5' SAMPLE.	Recovered 1 7/2 5' = 68%	7 0-9 5' Readings on Core HNu=750, OVA=0 2
		7 0-8 3' CALICHE same as above		
		8 3-8 7' GRAVEL with caliche, similar to caliche above, dry, spotted with moist areas		7 0 8 7' Direct Hit/Upper Contact Sample SP048707DH
		<u>ARAPAHOE FORMATION</u>		
		9 5 12 0' SAMPLE	Recovered 0 6/2 5' = 24%	10 5' Readings in Breathing Zone HNu=0.6, OVA=2.5
		SANDSTONE yellowish gray (5 Y 7/2, contains small pebbles, grains are rounded to subrounded, coarse-grained, some clay, very moist		9 5-11 1' Readings on Core HNu=20, OVA=7 8
15		12 0 14 5' SAMPLE	Recovered 2 9/2 5' = 116%	9 5 11 1' Direct Hit/Contact Sample SP048710DH (VOAs only)
		12 0 12 2' GRAVEL moderate yellowish brown (10 YR 5/4), some clay and sand, wet		
		12 2 14.5' CLAYSTONE light olive gray (5 YR 5/2), mottled with dark yellowish orange (10 YR 6/6), moist		12 0-14 5' Readings on Core. HNu=85, OVA=3 3
20				12.0 14 5' Direct Hit/Water Table/ Bedrock Sample SP048712DH

LOG
OF
BOREHOLE

Location <u>Rocky Flats Plant, Solar Ponds Area</u>	Borehole/Well No <u>SP04-87(cont'd)</u>
Coordinates _____	Ground Surface Elevation _____
Total Depth _____	Water Level Encountered _____
	Static _____
Drilling Company _____	Driller _____
Date Drilled _____	Helper _____
Drilling Method _____	Drilling Fluid _____
Logged By _____	Checked By _____
Geologist	Site Manager
	CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<p><u>14 5 17 0' SAMPLE</u> Recovered 2.7/2.5' = 108%</p> <p>14 5-15 1' CLAYSTONE light olive gray (5 Y 5/2) stained with dark yellowish orange (10 YR 6/6), blocky structure, concretions of caliche, moist</p> <p>15 1-17.0' Same as above, wet</p>	<p><u>14.5-17 0'</u> Readings on Core HNU=1 0, OVA=2.8</p>
			<p><u>17 0-19 5' SAMPLE</u> Recovered 2.6/2.5' = 104%</p> <p>17 0-17 2' CLAYSTONE same as above</p> <p>17.2-18 3' CLAYSTONE dark yellowish orange (10 YR 6/6), slightly moist</p> <p>18.3-19 5' CLAYSTONE olive gray (5 Y 3/2) mottled with dark yellowish orange (10 YR 6/6), very slightly moist</p>	<p><u>14 5-17 0'</u> Field Screen Reading HNU=650(0 5), OVA=3 6(32)</p>
25			<p><u>19 5 22 0' SAMPLE</u> Recovered 2 6/2 5' = 104%</p> <p>CLAYSTONE same as above</p>	<p><u>14 5-17 0'</u> Field Screen Sample SP048715FS</p>
			<p><u>22 0 24 5' SAMPLE</u> Recovered 2 5/2 5' = 100%</p> <p>CLAYSTONE same as above except a little more sand</p>	<p><u>17 0-19 5'</u> Readings on Core HNU=45, OVA=3 2</p>
30			<p><u>24 5-27 0' SAMPLE</u> Recovered 2 5/2.5' = 100%</p> <p>24.5-25 0' CLAYSTONE same as above except less sand, more consolidated and dry</p> <p>25 0-27 0' CLAYSTONE olive gray (5 Y 2/2), some coal, slightly sandy, dry</p>	<p><u>17 0-19 5'</u> Direct Hit Sample SP048717DH</p>
			<p><u>27.0-29.5' SAMPLE.</u> Recovered 2.5/2.5' = 100%</p> <p>CLAYSTONE same as above except layers of oxidation from 0 2 to 0 4 ft in thickness, dark yellowish orange (10 YR 6/6), grades from pure claystone at the top to very sandy claystone at the bottom, pockets of caliche in unweathered areas, dry</p>	<p><u>19 5-22 0'</u> Readings on Core HNU=60, OVA=3 0</p>
35			<p><u>29 5 32 0' SAMPLE</u> Recovered 2 7/2 5' = 108%</p> <p>CLAYSTONE same as above except much more sandy, dry</p>	<p><u>19 5-22 0'</u> Direct Hit Sample. SP048720DH</p>
40				<p><u>22 0-24.5'</u> Readings on Core HNU = 450, OVA = 30</p>
				<p><u>22.0-24.5'</u> Direct Hit Sample SP048722DH</p>
				<p><u>24.5-27 0'</u> Readings on Core HNU=45, OVA=3.0</p>
				<p><u>24.5-27.0'</u> Direct Hit Sample SP048725DH</p>
				<p><u>27 0-29 5'</u> Readings on Core HNU=4 0, OVA=5 8</p>
				<p><u>27.0-29 5'</u> Direct Hit Sample SP048727DH</p>
				<p><u>29 5 32.0'</u> Readings on Core HNU=0.0, OVA=5 4</p>
				<p><u>29 5 32.0'</u> Direct Hit Sample. SP048730DH</p>

LOG
OF
BOREHOLE

Location Rocky Flats Plant; Solar Ponds Area

Coordinates _____

Total Depth _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By _____

Geologist

Borehole/Well No SP04-87 (cont'd)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>32 0-34 5' SAMPLE.</u> Recovered 2 7/2 5' = 108% CLAYSTONE dark yellowish orange (10 YR 6/6) mottled with grayish orange pink (5 YR 7/2), very thin seams of coal, no HCl reaction, weathered, slightly moist</p>	<p><u>32 0-34 5'</u> Readings on Core HNU=0 2, OVA=1.8</p>
			<p><u>34 5-37 0' SAMPLE</u> Recovered 2.5/2 5' = 100% CLAYSTONE olive gray (5 Y 3/2) mottled with dark yellowish orange (10 YR 6/6), sandy, contains some coal, dry</p>	<p><u>34 5 37 0'</u> Readings on Core HNU=0 0, OVA=0 5</p>
				<p><u>34 5 37 0'</u> Field Screen Readings HNU=0(0 0), OVA=0 8(0 8)</p>
			TOTAL DEPTH 37 0'	

INDEX OF DATA

Boring No SP05-87

Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdriograph

LOG OF BOREHOLE

Location Rockv Flats Plant, Solar Ponds Area

Coordinates * N 37865 E 21810

Total Depth 21 8'

Borehole Well No SP05-87

Ground Surface Elevation *5971.6'

Water Level Encountered 15 3'

Static _____

Drilling Company Bovles Bros

Date Drilled November 5 and 6, 1987

Drilling Method Hollow Stem Auger

Logged By J Bacchus

Geologist

Driller R. Sharp

Helper T Merritt, S Bradfield

Drilling Fluid None

Checked By _____

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement
*Coordinates and elevation estimated from topographic map.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>TOPSOIL</u>	
			<u>0 0-2 0' SAMPLE</u> Recovered 0 4/2 0' = 20% SOIL moderate yellowish brown (10 YR 5/4), roots, sand, clay, silt, dry	HNu Background=1 2 OVA Background=0.8 No Ludlum readings taken
			<u>ARTIFICIAL FILL/DISTURBED</u>	
			<u>2 0 4 0' SAMPLE</u> Recovered 1 3/2 0' = 65% GRAVEL dusky yellowish brown (10 YR 2/2) small cobbles, pebbles, sand, silt, and clay, angular particles, wet to moist	<u>0 0-0 4' Readings on</u> Core HNu = 1 0, OVA = 1.2
5			<u>4 0 7 0' SAMPLE</u> Recovered 1 6/3 0' = 53% 4 0-4 7' GRAVEL same as above 4 7 7 0' CLAY dark reddish brown (10 R 3/4), some sand and small angular cobbles, dense, dry	<u>0 0-0 4' Direct Hit</u> Sample SP058700DH (VOAs and Rads only)
			<u>7 0-9 5' SAMPLE</u> Recovered 1 3/2 5' = 52% SAND very pale orange (10 YR 8/2) and dark yellowish orange (10 YR 6/6), sand, silt, and cobbles, high amount of caliche, poorly sorted, dry	<u>2 0 3 3' Reading on</u> Core HNu=0 8, OVA=11
10			<u>9 5 12 0' SAMPLE</u> Recovered 1 1/2 5' = 44% SAND same as above except slightly moist near the bottom	<u>2 0 3 3' Direct Hit</u> Sample SP058702DH
			Total depth of borehole measured 12 8', adjust depth	<u>4 0 5 6' Readings on</u> Core HNu=0 8, OVA=4 8
			<u>12 8 15 3' SAMPLE</u> Recovered 1 6/2 5' = 64% SAND light olive gray (5 Y 5/2), small cobbles, pebbles, silt, clay clasts are angular, slight HCl reaction, wet on top 0 3 ft, moist in the rest of the run	<u>4 0 5 6' Direct Hit</u> Sample SP058704DH
15			<u>15 3-17 3' SAMPLE</u> Recovered 2 0/2 0' = 100% 15 3 16.3' GRAVEL same as above except less sand, strong HCl reaction, very wet	<u>7 0-8 3' Readings on</u> Core HNu=9, OVA=7 8
				<u>7 0-8 3' Direct Hit</u> Sample SP058707DH
				<u>9 5 10.6' Readings on</u> Core HNu=3.0, OVA=4 8
				<u>9 5 10 6' Direct Hit</u> Sample SP058710DH
				<u>12 8 14 4' Readings on</u> Core HNu=2.2, OVA=2.8
				<u>12 8 14 4' Direct Hit</u> Sample SP058712DH
				<u>15.3 17.3' Readings on</u> Core HNu=1 0, OVA=2 8
20				<u>15 3 17 3' Direct Hit</u> Sample SP058716DH.

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates _____

Total Depth _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By _____

Geologist

Borehole/Well No SP05-87(cont'd)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

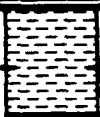
Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>ARAPAHOE FORMATION</u> <u>17 8 19 8' SAMPLE</u> Recovered 2 2/2 0' = 110% CLAYSTONE dusky yellow (5 Y 6/4) to light olive gray (5 Y 5/2) mottled with dark yellowish orange (10 YR 6/6), blocky structure, no HCl reaction, moist to wet <u>19 8-21 8' SAMPLE</u> Recovered 2 2/2 0' = 110% CLAYSTONE Same as above except small pockets of caliche, moist TOTAL DEPTH 21 8'	<u>17 8 19 8' Field Screen</u> Readings: HNU=0.0(0.0), OVA=0 4(0 4) <u>19 8-21 8' Field Screen</u> Readings: HNU=0 0(0 0), OVA=0 4(0 4).
25				
30				
35				
40				

INDEX OF DATA

Boring No SP06-87

Completed as well? No

Data in File

- λ Log of Borehole
- Well Construction Summaries
- Well Development Summaries
- Hydraulic Conductivity Test Data
and Results
- Packer Test Data and Results
- Water Level Data
- Saturated Thickness Hvdriograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area
Coordinates * N 37900 E 22100
Total Depth 30 7'

Borehole/Well No SP06-87
Ground Surface Elevation *5972.9'
Water Level Encountered None

Drilling Company Bovles Bros
Date Drilled November 18 and 19, 1987
Drilling Method Hollow Stem Auger
Logged By J Bacchus
Geologist

Static _____
Driller R. Sharp
Helper T Merritt
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement.
*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	HNu Background=0.7 OVA Background=0.8 Ludlum Background=0.0
		<u>0 0-2.0' SAMPLE</u>	Recovered 0 7/2 0' = 35%	
		<u>0 0 0 4'</u>	SOIL dark yellowish brown (10 YR 4/2), sandy; grass and roots, wet to moist	<u>0 0 0 7'</u> Readings on Core HNu = 0 2, OVA = 0 7
		<u>0 4-0.7'</u>	CLAY moderate yellowish brown (10 YR 5/4) mottled with very pale orange (10 YR 8/2), caliche, sand, small angular cobbles, moist	<u>0 0 0 7'</u> Field Screen Readings. HNu=0 4(0 3), OVA=0 6(0 6)
5		<u>2 0-4 0' SAMPLE</u>	Recovered 1 7/2 0' = 85%	
			CLAY same as above, except slightly larger clasts, moist	<u>2 0 3 7'</u> Readings on Core HNu=0 6, OVA=0 7
		<u>4 0-5 0' SAMPLE</u>	Recovered 0.0/1 0' = 0%	
			QUARTZITE angular block	<u>2 0-3 7'</u> Field Screen Readings HNu=400(45), OVA=0 8(0 6)
		<u>5 0-8 0' SAMPLE</u>	Recovered 1 5/3 0' = 50%	
			CLAYEY SAND dark yellowish orange (10 YR 6/6), large angular pebbles, slight HCl reaction, dry	<u>2 0 3 7'</u> Field Screen Sample SP068702FS
10		<u>8 0-10 5' SAMPLE</u>	Recovered 2 4/2 5' = 96%	
		<u>8 0-10.0'</u>	SOIL dusky brown (5 YR 2/2), roots, clay, sand, silt, and small angular cobbles, dry	<u>5 0-6.5'</u> Field Screen Readings HNu=0 4(0 4), OVA=0.0(0.0)
		<u>10 0 10 4'</u>	SAND pale yellowish brown (10 YR 6/2), contains clay and silt, small angular cobbles, no HCl reaction, dry	<u>8 0-10 4'</u> Readings on Core HNu=0.0, OVA=1 7
		<u>10 5-13 0' SAMPLE</u>	Recovered 1 9/2 5' = 76%	
			CALICHE very pale orange (10 YR 8/2), sand, silt, clay, small cobbles and pebbles, clasts are angular, dry to slightly moist	<u>8 0-10.4'</u> Direct Hit Sample. SP068708DH
15		<u>13 0 15 5' SAMPLE</u>	Recovered 1 3/2 5' = 52%	
			CALICHE same as above except the sample is coarser at the bottom	<u>10 5-12.4'</u> Readings on Core HNu=5 0, OVA=1 9, Ludlum=1
		<u>15 5 18 0' SAMPLE</u>	Recovered 1.2/2 5' = 48%	
			CALICHE same as above but not as coarse, more small angular cobbles, slightly moist	<u>10 5 12 4'</u> Direct Hit Sample SP068711DH
				<u>13 0 14 3'</u> Readings on Core HNu=1 2, OVA=20.0, Ludlum=1
20				<u>13 0 14 3'</u> Direct Hit Sample SP068713DH

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Borehole/Well No SP06-87(cont'd.)

Coordinates _____

Ground Surface Elevation _____

Total Depth _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			ARAPAHOE FORMATION	
		18 0 20 5' SAMPLE	Recovered 5 0/2.5' = 200%	15 5-17 7' Readings on Core HNu=1 0, OVA=3 0
		CLAYSTONE	light olive gray (5 Y 5/2) mottled with dark yellowish orange (10 YR 6/6), some sand near the bottom of the run, pockets of caliche, moist	15 5-17 7' Direct Hit Sample SP068716DH
		20 5 23 0' SAMPLE	Recovered 3 3/2.5' = 132%	18 0 20 5' Readings on Core HNu=0 0, OVA=2.3
		20.5-21 0' SANDSTONE	dark yellowish orange (10 Y 6/6) mottled with very pale orange (10 YR 8/2), grains are well rounded, high amount of caliche, well rounded pebbles, dry	18 0-20 5' Direct Hit Sample SP068718DH
25		21 0-23 0' CLAYSTONE	light olive gray (5 Y 6/2) mottled with dark yellowish orange (10 YR 6/6), pockets of sand, no caliche, slightly moist to dry	20 5-23 0' Readings on Core HNu=0 0, OVA=2 0
			Total depth of borehole measured 23.2', adjust depth	20.5-23.0' Direct Hit Sample SP068721DH
		23 2-25 7' SAMPLE	Recovered 2 5/2.5' = 100%	23 2-25.7' Readings on core HNu = 2 2, OVA = 7 4
30		CLAYSTONE	same as above	23.2-25 7' Direct hit sample SP068724DH
		25 7-28 2' SAMPLE	Recovered 2.8/2 5' = 112%	25 7-28 2' Readings on core HNu = 1 0, OVA = 6 4
		CLAYSTONE	olive gray (5 Y 3/2), slightly weathered, contains sand near the top of the run, dry	25 7-28 2' Direct hit sample: SP068726DH.
		28 2 30 7' SAMPLE	Recovered 3 0/2 5' = 120%	28 2-30 7' Readings on core HNu = 1 0, OVA = 1 8, Ludlum = 5
35		CLAYSTONE	olive gray (5 Y 3/2), mottled with light brown (5 YR 5/6), slightly sandy, blocky structure, dry	28 2-30.7' Field screen readings: HNu = 1.0(1 0), OVA = 1 4(1 4)
			TOTAL DEPTH 30 7'	
40				

INDEX OF DATA

Boring No SP07-87

Completed as well? No

Data in File

 X Log of Borehole
 Well Construction Summaries
 Well Development Summaries
 Hydraulic Conductivity Test Data
 and Results
 Packer Test Data and Results
 Water Level Data
 Saturated Thickness Hydiograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates * N 37485 E 22100

Total Depth 31.0'

Borehole/Well No SP07-87

Ground Surface Elevation *5973.6'

Water Level Encountered 18 0'

Drilling Company Boyles Bros.

Date Drilled November 12 and 13, 1987

Drilling Method Hollow Stem Auger

Logged By J. Bacchus

Geologist

Static _____

Driller R Sharp

Helper T Merritt

Drilling Fluid None

Checked By _____

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement.

*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	HNu Background = 0.0-0.8 OVA Background = 0.0-0.6 Ludlum Background = 0.0
		<u>0 0 2 0' SAMPLE</u>	Recovered 1 8/2 0' = 90%	
			CLAY moderate yellowish brown (10 YR 5/4), small angular cobbles, pebbles, sand and silt, green grass and roots, caliche, moist	<u>0 0 1 8'</u> Readings on core HNu = 0.1, OVA = 6.0
		<u>2 0 4 0' SAMPLE</u>	Recovered 1 8/2 0' = 90%	
			2 0-2.2' CLAY same as above	<u>0 0-1 8'</u> Direct hit sample SP078700DH
5			<u>ROCKY FLATS ALLUVIUM</u>	<u>2 0 3 8'</u> Readings on core HNu = 4.0; OVA = 11
			2 2 2 5' GRAVEL dark reddish brown (10 R 3/4), clasts are very angular quartzite, clay in between clasts, very sticky, moist	<u>2 0-3 8'</u> Direct hit sample SP078702DH
			2 5 3 8' CLAY moderate brown (5 YR 4/4), pebbles, sand and silt, dry	<u>4 0 5 0'</u> Readings on core HNu = 0.8, OVA = 0.0
		<u>4 0 5 0' SAMPLE</u>	Recovered 1.2/1.0' = 120%	
			CLAY same as above except much larger clasts, dry	<u>4 0 5 0'</u> Field screen readings HNu = 0.5(0.5), OVA = 0.6(0.5)
10		<u>5 0-8 0' SAMPLE</u>	Recovered 1 3/3 0' = 43%	
			5 0-5 8' CLAY Same as above	<u>5 0 6 3'</u> Readings on core HNu = 0.6, OVA = 0.0
			5 8-6.3' CLAY dusky yellowish brown (10 YR 2/2) at the top grading to dark yellowish orange (10 YR 6/6) at the bottom, gravel, sand and silt, pockets of caliche, slightly moist to dry	<u>5 0-6 3'</u> Field screen readings HNu = 0.5(0.5), OVA = 0.4(0.4)
		<u>8 0-10 5' SAMPLE</u>	Recovered 2 3/2 5' = 92%	
			8 0-8 5' CLAY same as above	<u>8 0 10 3'</u> Readings on core HNu = 0.5, OVA = 0.8
			8.5-10 3' CLAY dusky brown (5 YR 2/2), roots, caliche, cobbles, sand, pebbles, silt, moist	<u>8 0 10 3'</u> Field screen readings HNu = 0.3(2.2), OVA = 6.8(3.2)
15		<u>10 5 13 0' SAMPLE</u>	Recovered 1 7/2 5' = 68%	
			10 5 11.3' CLAY same as above except slightly more wet	<u>8 0-10 3'</u> Field screen sample SP078708FS
			11 3-12.2' SILT pale yellowish brown (10 YR 6/2), clasts of angular pebbles and coarse-grained sand, no HCl reaction, dry	<u>10.5-12.2'</u> Readings on core HNu = 1.0, OVA = 24.
				<u>10.5-12.2'</u> Direct hit sample SP078711DH
20				

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Borehole/Well No SP07-87(cont'd.)

Coordinates _____

Ground Surface Elevation _____

Total Depth _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<p><u>13 0-15 5' SAMPLE</u> Recovered 1.8/2 5' = 72% 13 0 13 8' SILT same as above 13 8-14 8' CLAY mottled dark greenish yellow (10 Y 6/6) and grayish olive (10 Y 4/2), sand, silt, pebbles and small cobbles, moist</p> <p><u>15 5-18.0' SAMPLE</u> Recovered 1.2/2.5' = 48% SAND grayish orange (10 YR 7/4), coarse, clay, large angular pebbles, high amount of caliche, moist</p> <p><u>18 0-20 5' SAMPLE</u> Recovered 1 3/2 5' = 52% SAND Same as above but more coarse, wet</p> <p><u>20 5 23 0' SAMPLE</u> Recovered 3 8/2 5' = 155% 20 5 21 3' SAND same as above</p> <p><u>ARAPAHOE FORMATION</u></p> <p>21 3 23 0' CLAYSTONE light olive gray (5 Y 5/2) mottled with pale yellowish orange (10 YR 8/6), dense, moist</p> <p><u>23 0-26 0' SAMPLE</u> Recovered 5 0/3 0' = 167% CLAYSTONE same as above</p> <p><u>26 0 28 5' SAMPLE</u> Recovered 3 0/2 5' = 120% 26 0 27 2' CLAYSTONE same as above 27 2 28.5' CLAYSTONE olive gray (5 Y 3/2), mottled with light brown (5 YR 5/6), dense, dry</p> <p><u>28 5-31 0' SAMPLE</u> Recovered 3 3/2 5' = 132% CLAYSTONE same as above</p> <p>TOTAL DEPTH: 31 0'</p>	<p><u>13 0 14 8'</u> Readings on core HNU = 0 4, OVA = 30</p> <p><u>13 0-14.8'</u> Direct hit sample SP078713DH</p> <p><u>15 5-16 7'</u> Readings on core HNU = 1 0, OVA = 11</p> <p><u>15 5 16 7'</u> Direct hit sample SP078716DH</p> <p><u>18 0-19 3'</u> Readings on core HNU = 0.6, OVA = 11</p> <p><u>18 0 19 3'</u> Water table sample SP078718WT</p> <p><u>20 5 23 0'</u> Readings on core HNU = 1020, OVA = 2 0</p> <p><u>20 5-23 0'</u> Contact sample SP078721CT</p> <p><u>23 0-26 0'</u> Readings on core HNU = 95, OVA = 5.2</p> <p><u>23.0-26 0'</u> Bedrock sample SP078723BR</p> <p><u>26 0-28 5'</u> Readings on core HNU = 0 6, OVA = 4 0, Ludlum = 2</p> <p><u>26 0-28 5'</u> Direct hit sample SP078726DH</p> <p><u>28 5 31 0'</u> Readings on core HNU = 0 6, OVA = 0 2, Ludlum = 1</p> <p><u>28 5-31 0'</u> Field screen readings HNU = 140(140), OVA = 0 5(0 4)</p>
25				
30				
35				
40				

INDEX OF DATA

Boring No 39-87BR/SP08-87

Completed as well? Yes

Data in File

- X Log of Borehole
- X Well Construction Summaries
- Well Development Summaries
- Hydraulic Conductivity Test Data
and Results
- Packer Test Data and Results
- Water Level Data
- Saturated Thickness Hvdriograph

LOG OF BOREHOLE

Location Rocky Flats Plant; Solar Pond Area
Coordinates N 38094.04 E 22166 32
Total Depth 140.00'

Borehole/Well No 39-87BR/SP08-87
Ground Surface Elevation 5947 10'
Water Level Encountered _____

Drilling Company Boyles Bros
Date Drilled Oct 29-30 and Nov 6-10, 1987
Drilling Method Hollow Stem Auger, NC Core
Logged By R. Treat, K.D. Hollaway
Geologist

Static _____
Driller T High
Helper B Keenev
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
			<u>00-2.0 SAMPLE</u> Recovered 07/20' = 35% GRAVEL AND CLAY dark dusky brown (5 YR 2/2) to mixed light brown, weakly cemented, subangular, subrounded quartzite gravel poorly sorted low plastic, slightly sandy, fine-grained, light moist	HNu background=0.2 OVA Background=2.8 Ludlum background = 0.0
5			<u>2.0-3.5 SAMPLE</u> Recovered 15/15' = 100% 2.0-3.2' GRAVEL AND CLAY dark yellowish orange (10 YR 6/6) to moderate yellowish orange (10 YR 5/4) with gravel to 4.00 mm and larger sand varying (2.0-1.5 Ø to 0.5-1.0 Ø), light moist 3.2-3.5' CLAY dark yellowish orange (10 YR 6/6) moderately cemented, slightly sandy, fine-grained, occasional small scattered gravel, highly plastic, very moist	0.0-2.0 Field screen readings HNu = 0.2 (0.2), OVA = 2.8 (2.8) No ludlum readings above background
10			<u>3.5-6.5 SAMPLE</u> Recovered 30/30 = 100% 3.5-5.2' CLAY moderate brown (5 YR 4/4) to varying gray, considerably oxide stained low plastic, fine-grained sand (3.0-2.5 Ø), weakly cemented, claystone fragments, moist	2.0-3.5 Field screen readings HNu = 0.2 (0.2) OVA = 2.8 (2.8) No ludlum readings above background
15			<u>ARAPAHOE FORMATION</u> 5.2-6.5 CLAYEY SANDSTONE light gray (N 7/0), fine-grained sand (3.0-2.5 Ø) and finer, weakly cemented, weathered, moist	3.5-6.5 Upper contact sample SP088703UC 6.5-8.5' Contact sample SP088706CT 9.0-11.5' Bedrock sample SP088709BR 11.5-14.0' Field screen readings HNu = 0.2 (0.2), OVA = 2.8 (2.8) 14.0-16.5' Field screen readings HNu = 0.2 (0.2), OVA = 2.8 (2.8)
20				

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>6.5-9.0 SAMPLE.</u> Recovered 20/25 = 80% SANDSTONE light gray (N 7/0) to severely oxide stained brown, fine-grained sand (30-25 Ø), weakly cemented massive, slight clay binder weathered moist	<u>19.0'</u> Readings in augers HNu = 0, OVA = 28
25			<u>9.0-11.5 SAMPLE.</u> Recovered 25/25 = 100% CLAYEY SANDSTONE varying oxide (Fe) browns to grays fine-grained sand as above massive, weakly cemented weathered, moist	
30			<u>11.5-14.0' SAMPLE.</u> Recovered 15/25 = 60% CLAYEY SANDSTONE as stated above continued moderately oxide stained weathered	
35			<u>14.0-16.5 SAMPLE.</u> Recovered 20/25' = 80% CLAYEY SANDSTONE light gray (N 7/0) to severely oxide stained brown, sand (30-25 Ø), massive, low plastic, weakly to moderately cemented weathered moist	
40			<u>16.5-19.0 SAMPLE.</u> Recovered 23/25 = 92% CLAYEY TO VERY CLAYEY SANDSTONE oxide stained brown to light gray low plastic massive weakly cemented weathered moist	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
40			<p><u>19.0-21.5' SAMPLE</u> Recovered $14\frac{1}{2}5' = 56\%$ CLAYEY SANDSTONE moderately oxide stained to light gray (N 7/0) massive, fine-grained, weathered, moist</p> <p><u>21.5-24.0' SAMPLE</u> Recovered $18\frac{1}{2}5' = 72\%$ CLAYEY SANDSTONE light gray (N 7/0) to severely oxide stained brown, low plastic sands (3.5-3.0 Ø to 2.5-2.0 Ø), weakly cemented, massive, moist</p> <p><u>24.0-26.5' SAMPLE</u> Recovered $12\frac{1}{2}5' = 60\%$ 24.0-25.0' CLAYEY SANDSTONE as noted above moist 25.0-25.2' CLAYSTONE medium gray (N 4/0), massive blocky, remaining slightly sandy (3.5-3.0 Ø), low plastic weathered moist</p> <p><u>26.5-29.0' SAMPLE</u> Recovered $25\frac{1}{2}5' = 100\%$ CLAYSTONE medium gray (N 7/0) massive medium plastic slightly blocky now only slightly oxide stained in streaks at 28.5 and 28.8 for 2 streaks</p> <p><u>29.0-31.5' SAMPLE</u> Recovered $13\frac{1}{2}5' = 52\%$ SANDY CLAYSTONE as noted above but now moderately oxide (Fe) stained massive medium plastic, weathered, moist</p>	<p><u>50.10-59.75' Packer Test Interval #10</u></p> <p><u>59.75-69.40' Packer Test Interval # 9</u></p>
45				
50				
55				
60				

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
60			<u>31.5-34.0' SAMPLE</u> Recovered 2 2/2 5' = 88% SANDY CLAYSTONE upper formation (31.5-32.0') then slightly sandy, fine- grained, severely oxide stained brown to a light medium gray (N 6/0), massive low to medium plastic, weathered, blocky, moist	<u>69-40-79.05</u> Packer Test Interval # 8
65			<u>34.0-36.5' SAMPLE</u> Recovered 2 5/2 5' = 100% CLAYSTONE dark gray (N 3/0) to medium gray (N 5/0), massive medium plastic blocky, slightly sandy, fine- grained moist	
70			<u>36.5-39.0 SAMPLE</u> Recovered 1 7/2 5' = 68% CLAYSTONE moderate brown (5 YR 4/4) to medium dark gray (N 6/0), massive, blocky medium plastic, slightly sandy, weathered, streaked moist	
75			<u>39.0-41.5 SAMPLE</u> Recovered 2 2/2 5' = 88% CLAYSTONE/SHALE medium dark gray (N 4/0), massive blocky slightly sandy, fine-grained, medium plastic, moist	
80			<u>41.5-44.0' SAMPLE</u> Recovered 1 2/2 5' = 48% CLAYSTONE/SHALE medium dark gray (N 4/0), massive, medium plastic somewhat blocky, just slightly sandy light moist	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
80			<p><u>41.3-45.4 SAMPLE</u> Recovered 168/410' = 41% ROD = 104/168' = 62%</p> <p>41.3-41.8' CLAYSTONE PLUG 41.8-42.35 SILTY CLAYSTONE dark gray (N 3/0) to olive black (5 Y 2/1), some very fine-grained sand, well sorted unconsolidated blocky, soft to medium hardness, damp 42.35-44.03 SANDY SILTY CLAYSTONE olive black (5 Y 2/1), sand very fine-grained (3.5-4.0 Ø), well sorted, consolidated blocky medium hardness some organics, damp</p> <p><u>45.4-49.5 SAMPLE</u> Recovered 410/410' = 100% ROD = 355/410' = 87%</p> <p>SANDY CLAYSTONE olive gray (5 Y 4/1) to olive black (5 Y 2/1), sand very fine-grained (3.5-4.0 Ø), well sorted, occasional lenses of a coarser grained sand (3.0-2.5 Ø) pinkish gray (5 YR 8/1) increasing down core when get into sandstone/claystone interbeds, consolidated, hard, at 45.80' have a leaf imprint occasional organics throughout core, damp</p>	<p><u>79.05-88.70</u> Packer Test Interval # 7 <u>88.70-98.35</u> Packer Test Interval # 6 <u>98.35-108.00</u> Packer Test Interval # 5</p>
85				
90				
95				
100				

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
100			<p><u>49.5-54.0 SAMPLE.</u> Recovered 4 20/4 50' = 93.30% ROD = 2 70/3 90' = 69% 49.5-50.7' SANDY CLAYSTONE olive gray (5 Y 3/2), cuttings from above, moist 50.7-54.0' SANDY CLAYSTONE olive gray (5 Y 4/1) to olive black (5 Y 2/1), same as 45.40-49.50 interval at 52.25' have some fine-grained sand stained dark yellowish orange (10 YR 6/6) lenses of fine-grained sand increase down core, at 53.5-54.0 clay is predominant, damp</p> <p><u>54.0-57.0 SAMPLE</u> Recovered 3 3/3 0 = 110% ROD = 2 45/3 30 = 74% SANDY CLAYSTONE same as above with nodules of very pale orange (10 YR 8/2) clay and very fine grained sand increasing down core at 56.22 have lost imprint less fine-grained sand lenses damp</p> <p><u>57.0-61.0 SAMPLE.</u> Recovered 4 0/4 0' = 100% ROD = 4 0/4 0' = 100% SANDY CLAYSTONE same as above with more fine-grained sand lenses, clay nodules still present more organics than above clay increases down core with 60.0-61.0' mostly clay, damp</p> <p><u>61.0-65.0 SAMPLE.</u> Recovered 0 0/4 0 = 0% Lost core</p>	<p><u>108.00-117.65</u> Packer Test Interval # 4 <u>115.65-125.30</u> Packer Test Interval # 3 <u>117.65-127.30</u> Packer Test Interval # 2 <u>122.68-132.33</u> Packer Test Interval # 1</p>
105				
110				
115				
120				

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
120			<p><u>650-66.0' SAMPLE</u> Recovered 15/10' = 150% RQD = 0% CLAYSTONE light greenish gray (5 GY 4/1) to dark greenish gray (5 GY 2/1) from 650-653, rest of core olive black (5 Y 2/1), trace very fine-grained sand core mangled from drilling appears unconsolidated and blocky, damp to moist</p>	
125			<p><u>660-70.0 SAMPLE</u> Recovered 50/40 = 125% RQD = 26/50' = 52% 660-675 CLAYSTONE olive black (5 Y 2/1) to brownish black (5 YR 2/1), trace silt and very fine-grained sand, some organics blocky consolidated, damp 675-685 CLAYSTONE olive black (5 Y 2/1) to brownish black (5 YR 2/1), trace silt and very fine-grained sand some organics blocky, consolidated damp 685-695 CLAYSTONE olive black (5 Y 2/1) to greenish black (5 GY 2/1) to black (N 1/0) trace silt blocky, damp 695-700 CLAYSTONE medium bluish gray (5 B 5/1) to medium gray (N 5/0), highly plastic, block, moist</p>	
130				
135			<p><u>700-74.0 SAMPLE</u> Recovered 06/40 = 15% RQD = 0% CLAYSTONE olive black (5 Y 2/1) to medium dark gray (N 4/0) blocky homogenous plastic damp</p>	
140				

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description ¹	Samples Collected or Other Tests Performed
			<u>740-760 SAMPLE</u> Recovered 3 85/20' = 193% RQD = 2 26/3 85 = 59% Picked up 1 85' from previous run 72 15-740 CLAYSTONE olive black (5 Y 2/1) with lenses of black (N 1/0), blocky, homogenous plastic damp 740-760 CLAYSTONE olive black (5 Y 2/1) to medium gray (N 5/0), blocky, homogenous plastic, damp	
			<u>760-800 SAMPLE</u> Recovered 2 13/40 = 53% RQD = 1 50/2 13 = 70% CLAYSTONE olive black (5 Y 2/1) some silt some organics trace very fine-grained sand interbeds homogenous, blocky, medium hardness, damp	
			<u>800-820' SAMPLE</u> Recovered 2 62/2 01 = 131% ROD = 1 62/2 62' = 62% SANDY CLAYSTONE olive black (5 Y 2/1) some very fine-grained sand poorly sorted subangular to subrounded fine-grained sand occurring in lenses and interbeds, some silt, some organics small coal seams, blocky, fairly homogenous medium hardness, damp	

LOG OF BOREHOLE

Location _____
 Coordinates _____
 Total Depth _____
 Drilling Company _____
 Date Drilled _____
 Drilling Method _____
 Logged By _____
 Geologist

Borehole/Well No 39-87BR/SP08-87 (con't.)
 Ground Surface Elevation _____
 Water Level Encountered _____
 Static _____
 Driller _____
 Helper _____
 Drilling Fluid _____
 Checked By _____
 Site Manager
 CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>820-840 SAMPLE</u> Recovered 2 38/20' = 119% RQD = 2 15/2 38' = 90% SANDY CLAYSTONE/CLAYEY SAND- STONE INTERBEDS olive black (5 Y 2/1) to dark gray (N 3/0), sand very fine- grained to fine-grained, poorly sorted, occurs in lenses and interbeds, occasional stringers of coal in small fractures with no orientation, some silt some organics consolidated medium hardness from 830-840 have small lenses of fairly well sorted fine-grained (30-25 Ø) sand subrounded quartzitic yellowish gray (5 Y 8/1) damp with sand lenses moist</p> <p><u>840-860 SAMPLE</u> Recovered 2 0/20' = 100% RQD = 1 76/20' = 86% SANDY CLAYSTONE olive black (5 Y 2/1) to dark gray (N 3/0) with yellowish gray (5 Y 8/1) fine-grained sand lenses occasional, poorly sorted, occasional stringers of coal some silt, some organics, consolidated, damp</p> <p><u>860-880 SAMPLE</u> Recovered 2 0/20' = 100% RQD = 2 0/20' = 100% SANDY SILTSTONE same as above except less sand no coal stringers damp</p>	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't.)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>880-920' SAMPLE</u> Recovered 40/40 = 100% RQD = 3 63/40' = 91% 880-910 SANDY SILTSTONE olive black (5 Y 2/1) and dark gray (N 3/0), some clay, lots of silt, some very fine- grained fairly well sorted sand with lenses of a fine-grained, well sorted sand, damp 910-920 SILTY SANDSTONE olive black (5 Y 2/1) with yellowish gray (5 Y 8/1) to pinkish gray (5 YR 8/1) fine- grained sand fairly well sorted, sand in lenses and interbeds some clay, some organics small planes of lamination present in sand lenses consolidated, damp	
			<u>920-960 SAMPLE</u> Recovered 40/40 = 100% RQD = 3 83/40' = 96% 920-9425' SILTY SANDSTONE olive black (5 Y 2/1) to yellowish gray (5 Y 8/1) very fine-grained to fine-grained sand, fairly well sorted some planes of lamination less silt and clay than above some occasional organics consolidated damp 9425-952 SANDY SILTSTONE/SILTY SANDSTONE same as above with finer grained sand damp 952-960 SILTY SANDSTONE same as 920-9425 damp	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description ¹	Samples Collected or Other Tests Performed
			<u>960-1000 SAMPLE</u> Recovered 4 3/40 = 107% ROD = 40/43' = 93% 960-9735' SANDY SILTSTONE olive black (5 Y 2/1), very fine-grained sand, fairly well sorted in siltstone matrix, some clay, some organics, some lamination planes consolidated, at 9610-9650' and 972-9735' have lenses of a light olive gray (5 Y 6/1) to olive black (5 Y 2/1), fairly well sorted, moist, fine-grained sand, damp 9735-990 SILTSTONE olive black (5 Y 2/1), very fine-grained sand yielding to claystone downcore and disappearing at 9885 consolidated some clay, lots silt occasional nodules of gravish orange (10 YR 7/4) clay, prominent from 9735-980 some organics, damp 990-1000' CLAYEY SILTSTONE olive black (5 Y 2/1), trace very fine-grained sand, lots of silt lots of clay, consoli- dated some organics, occasional gravish orange (10 YR 7/4) nodules of clay, damp	

LOG OF BOREHOLE

Location _____
 Coordinates _____
 Total Depth _____
 Drilling Company _____
 Date Drilled _____
 Drilling Method _____
 Logged By _____
 Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)
 Ground Surface Elevation _____
 Water Level Encountered _____
 Static _____
 Driller _____
 Helper _____
 Drilling Fluid _____
 Checked By _____
 Site Manager
 CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>100.0-104.0' SAMPLE.</u> Recovered 2 61/4 0' = 65 3% RQD = 2 50/2 61 = 96% 100 0-101 0 CLAYEY SILTSTONE olive black (5 Y 2/1), trace very fine-grained sand, fairly homogenous, consolidated damp 101 0-101 5 SILTY SANDSTONE yel- lowish gray (5 Y 8/1) to olive black (5 Y 2/1), sand from very fine-grained in upper portion to fine-grained in lower portion fairly well sorted, subrounded some silt, little clay, consolidated, damp to moist 101 5-102 61 CLAYSTONE medium dark gray (N 4/0) to dark gray (N 3/0) highlv plastic, blocky, homogenous no silt or sand, damp to moist <u>104 0-108 0' SAMPLE.</u> Recovered 4 0/4 0' = 100% RQD = 3 27/4 0' = 82% CLAYSTONE olive black (5 Y 2/1) to dark gray (N 3/0), trace silt, blocky, homogenous, damp to moist	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>108.0-112.0' SAMPLE</u> Recovered 3 9/40' = 98% RQD = 3 49/39 = 89.5% 108.0-110.0 SILTSTONE olive black (5 Y 2/1), some very fine-grained sand, some clay, some organics, fairly homogenous, consolidated, hard, more sand down core, damp 110.0-111.90' SANDSTONE dark greenish gray (5 G 4/1) to greenish gray (5 GY 6/1) with some yellowish gray (5 Y 8/1), very fine-grained (3.5-4.0 Ø) to fine-grained (3.0-2.5 Ø), fairly well sorted subangular to subrounded some silt trace clay some leaf and plant stem organics increases down core, sand fines as goes down core with occasional lenses of the coarser grains, massive, damp to moist	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>112.0-116.0' SAMPLE.</u> Recovered 4 67/40' = 117% RQD = 3 23/4 67' = 69% 112.0-112.5 SANDY SILTSTONE olive black (5 Y 2/1) 40% silt 40% organics, 20% sand, consolidated, damp to moist 112.5-115.75' SANDSTONE greenish gray (5 GY 6/1) to dark greenish gray (5 G 4/1) with some yellowish gray (5 Y 8/1), fine-grained (30-20 Ø) to medium- grained (20-15 Ø) sand, fining down core, occasional lenses of clay and silt associated with organics occurring throughout the core sand massive with zones of contorted bedding, consolidated at 112.75 have a fracture of coal with small fractures of coal or organics occur- ring throughout the core damp to moist 115.75-116.0 SILTY SANDSTONE olive black (5 Y 2/1) very silty sand fine grained to medium-grained as above occurring in lenses many organics with clay associated very hard consolidated damp	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>1160-120.0' SAMPLE.</u> Recovered 20/40 = 50% RQD = 045/20' = 22.5% 1160-1163 CUTTINGS OF SILTSTONE AND CLAYSTONE reworked 1163-1169' SANDY SILTSTONE olive black (5 Y 2/1) with yellowish gray (5 Y 8/1) and greenish gray (5GY 6/1) fine- grained sand in lenses, some clay, some organics massive, consolidated, damp to moist 1169-1180' CLAYEY SANDY SILT- STONE olive black (5 Y 2/1), heavy silt influence sand is very fine-grained some organics massive consolidated damp	

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 39-87BR/SP08-87 (con't)
Ground Surface Elevation _____
Water Level Encountered _____
Static _____
Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>120.0-122.0' SAMPLE</u> Recovered 4 6/2 0' = 230% RQD 3 97/4 6 = 86% 118 0-120 0' CLAYEY SILTSTONE olive black (5 Y 2/1) to greenish black (5 GY 2/1), trace very fine-grained sand, some organics, occasional seams of coal, massive blocky, fairly homogenous, consolidated, damp 120 0-121 4 CLAYEY SILTSTONE dark greenish grav (5 G 4/1) to greenish black (5 GY 2/1) trace very fine-grained sand in lenses, some organics, massive, consolidated damp 121 4-122 0 SANDSTONE dark greenish grav (5 G 4/1) to greenish black (5 GY 2/1), some silt in top of core giving way to sand, fine-grained to medium-grained (20-15 Ø) sand, subrounded to subangular feldspathic and quartzitic fairly well sorted massive, homogenous, consolidated, few organics, damp to moist</p>	

LOG OF BOREHOLE

Location _____
 Coordinates _____
 Total Depth _____
 Drilling Company _____
 Date Drilled _____
 Drilling Method _____
 Logged By _____
 Geologist

Borehole/Well No 39-87BR/SP08-87 (con't.)
 Ground Surface Elevation _____
 Water Level Encountered _____
 Static _____
 Driller _____
 Helper _____
 Drilling Fluid _____
 Checked By _____
 Site Manager
 CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>1220-1260 SAMPLE</u> Recovered 40/40 = 100% RQD = 365/40' = 91% 1220-12285' SANDSTONE greenish gray (5 G 6/1) to greenish black (5 G 2/1), some silt, fine-grained to medium-grained (2.5-1.5 Ø) sand, subrounded to subangular, fairly well sorted, some organics, massive consolidated, moist 12285-1260' SANDSTONE/SILTSTONE greenish gray (5 G 6/1) to greenish black (5 G 2/1), very fine-grained sand with lenses of fine-grained to medium-grained sand as above (1220-12285), some organics more than above clay influence with organics, sand decreases down core giving way to more silt a little clay, and more organics, massive, consolidated, damp <u>1260-1300' SAMPLE</u> Recovered 15/40' = 37.5% RQD = 0.75/1.5' = 50% SANDSTONE medium dark gray (N 4/0) to light gray (N 7/0), very fine-grained to fine-grained (3.5-2.5 Ø) feldspathic and quartzitic sand fairly well sorted, massive occasional trace lamination planes sand fines down core some organics, some silt, from 1273-1275 have zone of clay influence, moist to wet	

LOG
OF
BOREHOLE

Location _____

Coordinates _____

Total Depth _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By

Geologist

Borehole/Well No 39-87BR/SP08-87 (con't.)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>130.0-132.0' SAMPLE</u> Recovered 4 35/20' = 217 5% RQD = 3 68/4 35' = 84 6% 127 5-129 4 CLAYEY SILTSTONE dark greenish gray (5 G 4/1) to greenish black (5 G 2/1), no organics, hard, massive, fairly homogenous, consolidated, damp to dry 129 4-129 7 SILTY CLAYSTONE same as above damp to dry 129 7-130 0 SILTY SANDSTONE same as above with some clay very fine-grained sand moist 130 0-132 0 SILTY SANDSTONE dark greenish gray (5 G 4 1) to greenish gray (5 G 6 1) very fine grained (5-40 Ø) to fine grained (30-25 Ø) fairly well sorted sand some silt massive consolidated damp to moist</p>	
			<p><u>132 0-136 0 SAMPLE</u> Recovered 4 18/40 = 104 5% RQD = 3 76/4 18' = 90% 132 0-132 4' SANDSTONE dark greenish gray (5 G 4/1) to greenish gray (5 G 6/1) fine-grained (20-30 Ø) sand, fairly well sorted some silt, massive, consolidated damp 132 4-136 0 SILTY CLAYSTONE dark greenish gray (5 G 4/1) to greenish gray (5 G 6/1) trace very fine-grained sand silt in top of core gives way to clay down core fairly homogenous, massive, consolidated hard, no organics, damp</p>	

LOG
OF
BOREHOLE

Coordinates _____

Borehole/Well No 39-87BR/SP08-87 (con't.)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>136.0-140.0 SAMPLE</u></p> <p>Recovered 2 0/4 0' = 50%</p> <p>RQD = 0 6/2 0' = 30%</p> <p>CLAYSTONE medium gray (N 5/0) to dark gray (N 3/0), some silt homogenous, massive, blocky, no organics, damp</p> <p>TOTAL DEPTH 140 00'</p>	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, Solar Ponds Area Well No 39-87BR/SP08-87
 Coordinates N 38094 04 E 22166.32 Elevation Ground Surface 5947 10'
 Total Depth Well 117.39' Top of Casing 5949 12'
 Borehole 140.00'

Formation of Completion Arapahoe Formation

Casing Material Sch 5, Type 316, TFJ Stainless Steel

Casing Diameter 2" ID

Screen Material 0.010" wire wrap, Type 316, TFJ Stainless Steel

Surface Casing Diameter 5" ID

Date Installed November 17-18, 1987

Approved By _____

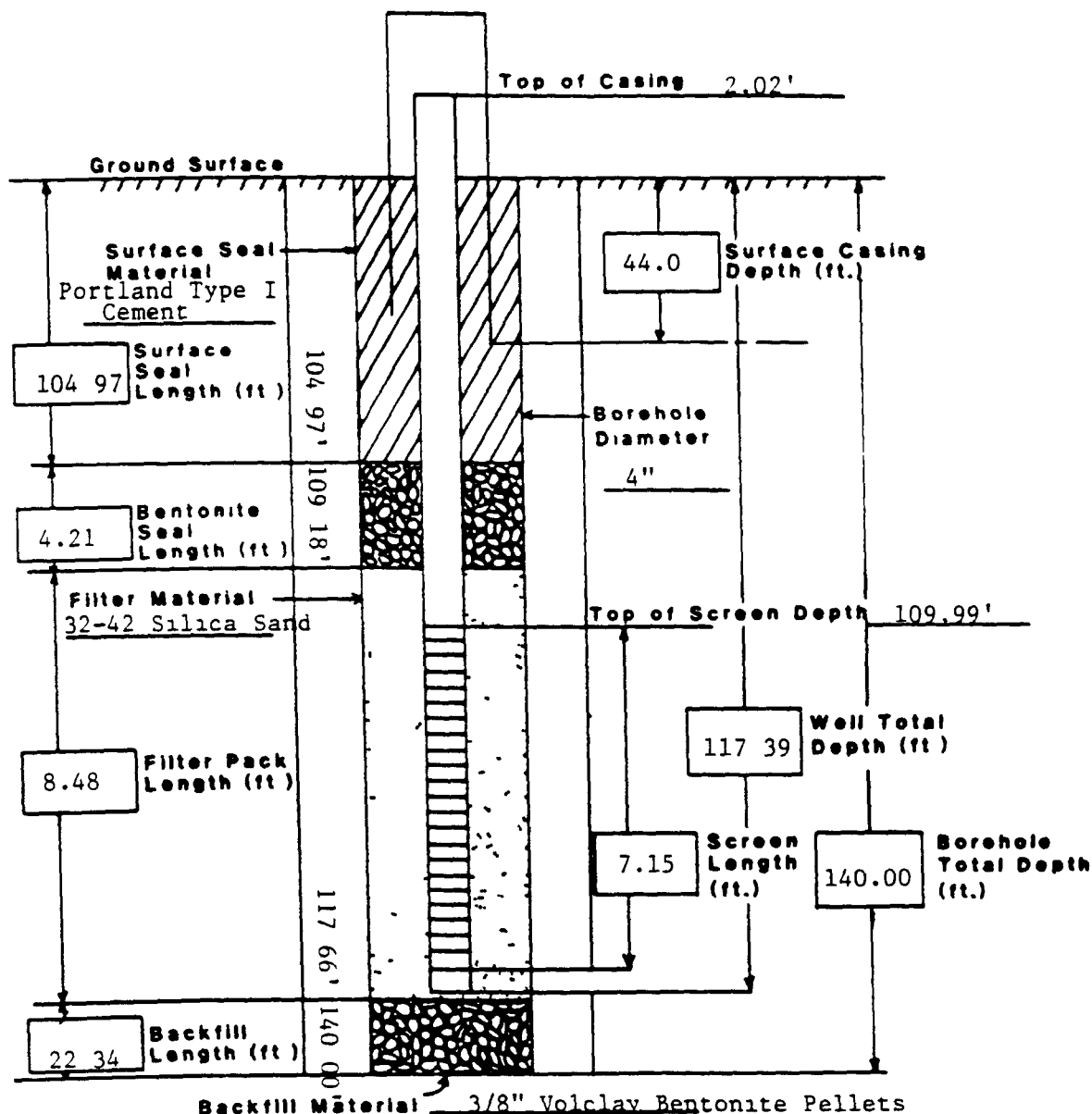
Installed By K.D Holliway

Site Manager

Geologist

CEARP Manager

Comments Surface casing set to 44 0' by R Treat on October 30, 1987



INDEX OF DATA

Boring No SP09-87

Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

LOG OF BOREHOLE

Location Rockv Flats Plant, Solar Ponds Area
Coordinates * N 38144 E 21872
Total Depth 11.0'

Borehole/Well No SP09-87
Ground Surface Elevation *5945.0'
Water Level Encountered None

Drilling Company Boyles Bros.
Date Drilled November 2, 1987
Drilling Method Hollow Stem Auger
Logged By R Treat
Geologist

Static _____
Driller T High
Helper B Keeney
Drilling Fluid None
Checked By _____

Site Manager
CEARP Manager

Comments Borehole backfilled with Portland Type I Cement.
*Coordinates and elevation estimated from topographic map.

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
			<u>0 0 1 5' SAMPLE</u> Recovered 1 3/1 5' = 87% CLAY dusky brown (5 YR 2/2), sandy with organic roots; few scattered gravels, low plastic, moist.	
			<u>1 5-3 0' SAMPLE</u> Recovered 1.1/1 5' = 73% 1 5 1 7' CLAY moderate yellowish brown (10 YR 5/4), fine-grained sand as noted above, moist 1 7 2 6' SAND AND GRAVEL few scattered gravels, varying light brown to medium dark brown, weakly cemented, poorly sorted, rounded and subrounded gravels ranging 0.75 mm to 4.25 mm; quartzose composition, light moist	HNu Background=0.3 OVA Background=0.0 Ludlum Background = 0.0
5			<u>3 0-6 0' SAMPLE</u> Recovered 2 1/3 0' = 70% 3 0-4 2' SAND AND GRAVEL mixed yellowish brown (10 YR 5/4), moderately oxide stained, fine- and medium-grained sand (2.5 2.0 ϕ to 0.0-0.5 ϕ), gravel subrounded and rounded quartzite, weakly cemented, lightly moist 4.2-5 1' CLAY yellowish gray (5 YR 7/2) to light olive brown (5 Y 5/6), moderately calcareous, highly plastic, moderately cemented, moist	<u>0 0 1.3'</u> Field screen readings: HNu = 0.0(0.0), OVA = 0.0(0.0) <u>1 5-2 6'</u> Field screen readings: HNu = 0.0(0.0), OVA = 0.0(0.0) <u>3 0-5 1'</u> Upper contact sample SP098703UC
10			<u>ARAPAHOE FORMATION</u>	<u>6 0-8 5'</u> Contact sample SP098706CT
			<u>6 0 8 5' SAMPLE</u> Recovered 3.5/2 5' = 140% CLAYSTONE medium gray (N 5/0), slightly oxide stained, medium plastic, blocky, weathered, massive; moist.	<u>8 5-11 0'</u> Bedrock sample SP0987088R
15			<u>8 5-11 0' SAMPLE</u> Recovered 2.5/2 5' = 100% CLAYSTONE sandy, medium gray (N 5/0), fine grained sand (3.5 3.0 ϕ), low plastic, massive, blocky, moderately oxide stained levels, weathered, moist	<u>8 5 11 0'</u> Field screen reading: HNu = 0.0(0.0), OVA = 0.0(0.0)
			TOTAL DEPTH 11 0'	
20				

INDEX OF DATA

Boring No SP10-87

Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

LOG OF BOREHOLE

Location Rockv Flats Plant, Solar Ponds Area
Coordinates * N 38185 E 21480
Total Depth 22 7'

Borehole/Well No SP10-87
Ground Surface Elevation *5941.0'
Water Level Encountered 21.0'

Drilling Company Boyles Bros
Date Drilled November 9-11, 1987
Drilling Method Hollow Stem Auger
Logged By J. Bacchus
Geologist

Static _____
Driller R. Sharp
Helper T. Merritt
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement.
*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
		<u>0 0 2 0' SAMPLE</u>	Recovered 1 8/2 0' = 90%	<u>0 0-1 8'</u> Direct hit sample SP108700DH
			CLAY dark yellowish brown (10 YR 4/2) mottled with dark yellowish orange (10 YR 6/6), silt and sand, abundant roots at the top, caliche, moist	
		<u>2 0-4 0' SAMPLE</u>	Recovered 1 9/2 0' = 95%	<u>2 0 3 9'</u> Direct hit sample SP108702DH
		<u>2 0 2 4'</u>	CLAY same as above	<u>4 0 5 0'</u> Direct hit sample SP108704BR.
5			<u>ARAPAHOE FORMATION</u>	<u>5 0-7 0'</u> Direct hit sample SP108705DH
		<u>2 4-3 9'</u>	CLAYSTONE dark yellowish orange (10 YR 6/6) mottled with very pale yellowish orange (10 YR 8/6) and pale olive (10 Y 6/2), sandy, caliche, moist	<u>7 0-9 0'</u> Direct hit sample SP108707DH
		<u>4 0 5 0' SAMPLE</u>	Recovered 1.6/1 0' = 160%	<u>9 0-11 0'</u> Direct hit sample SP108709DH
			CLAYSTONE same as above, moist	<u>11 0-13 0'</u> Direct hit sample SP108711DH
10		<u>5 0-7 0' SAMPLE</u>	Recovered 2.2/2 0' = 91%	<u>13 0-14 9'</u> Direct hit sample SP108713DH
			CLAYSTONE same as above, except less sand, less caliche, and slightly less oxidation	
		<u>7 0-9 0' SAMPLE</u>	Recovered 2.2/2 0' = 110%	
			CLAYSTONE. Same as above except more consolidated, no caliche, moist	
		<u>9 0 11 0' SAMPLE</u>	Recovered 2.0/2.0' = 100%	
			CLAYSTONE Same as above except moist to dry	
15		<u>11 0 13 0' SAMPLE</u>	Recovered 2.0/2 0' = 100%	
			CLAYSTONE light olive gray (5 Y 5/2) mottled with dark yellowish orange (10 YR 6/6), blocky structure, some fine grained sand, slightly moist	
		<u>13 0 15 0' SAMPLE</u>	Recovered 1 9/2 0' = 95%	
			SANDSTONE light olive gray (5 Y 5/2) mottled with dark yellowish orange (10 YR 6/6), fine- grained, high amount of clay, no HCl reaction, dry	
20				

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Borehole/Well No SP10-87(cont'd)

Coordinates _____

Ground Surface Elevation _____

Total Depth _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<p><u>15 0-17 0' SAMPLE</u> Recovered 1 9/2 0' = 95% SANDSTONE- same as above except less clay, coarser sand, sand gets coarser at bottom</p> <p><u>17 0-19 0' SAMPLE</u> Recovered 2 2/2 0' = 110% CLAYSTONE light olive gray (5 Y 5/2) and dark yellowish orange (10 YR 6/6), very sandy, fining downward, coarse sand at the top, clay at the bottom, dry</p> <p><u>19 0-21 0' SAMPLE</u> Recovered 2 2/2 0' = 110% CLAYSTONE light olive gray (5 Y 5/2) mottled with dark yellowish orange (10 YR 6/6), HCl reaction in the dark yellowish orange areas only, dry</p> <p><u>21 0-23 0' SAMPLE</u> Recovered 2 2/2 0' = 110% 21 0-21 4' CLAYSTONE same as above except some fine-grained sand and wet 21 4-23 0' CLAYSTONE light olive gray (5 Y 5/2), mottled with light yellowish orange, dry</p> <p>Total depth of borehole measured 22 7', adjust depth</p> <p><u>22 7-23 7' SAMPLE</u> Recovered 2 0/1 0' = 200% CLAYSTONE same as above</p> <p><u>23 7-25 7' SAMPLE</u> Recovered 2 0/2 0' = 100% CLAYSTONE same as above</p> <p><u>25 7-27 7' SAMPLE</u> Recovered 2 2/2 0' = 110% CLAYSTONE same as above, except a little less mottled</p> <p>TOTAL DEPTH 27 7'</p>	<p><u>15 0-16 9'</u> Direct hit sample SP108715DH</p> <p><u>17 0 19 0'</u> Direct hit sample SP108717DH</p> <p><u>17 0-19 0'</u> Duplicate sample SP1087017D</p> <p><u>19 0-21 0'</u> Direct hit sample SP108719DH</p> <p><u>21 0 23 0'</u> Water table sample SP108721WT</p> <p><u>22 7 23 7'</u> Direct hit sample SP108723DH</p> <p><u>23 7-25 7'</u> Direct hit sample. SP108724DH</p>
25				
30				
35				
40				

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Boring No SP11-87

Completed as well? No

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- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdriograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates * N 38590 E 21342

Total Depth 34 0'

Borehole/Well No SP11-87

Ground Surface Elevation *5904.5'

Water Level Encountered None

Static _____

Drilling Company Boyles Bros.

Driller T High

Date Drilled November 3-5, 1987

Helper B Keeney

Drilling Method Hollow Stem Auger

Drilling Fluid None

Logged By R. Treat

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement.
*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
		<u>0 0-1 5' SAMPLE</u>	Recovered 1 5/1.5' = 100%	<u>0 0-1.5'</u> Field screen reading HNu = 0 0(0 0), OVA = 0 0(0 0)
			0 0-0.3' SANDY CLAY dusky brown (5 Y 2/2), low plastic, roots, fill, light moist	
			0.3 1 5' CLAY dark yellowish orange (10 YR 6/6), fine-grained sand with gravel to 3 2 mm, subrounded and rounded, low plastic, sandy, gravel, moderately oxide stained, light moist	<u>1 5-3 5'</u> Field screen reading HNu = 0 0(0 0), OVA = 0 0(0 0)
5		<u>1 5-3.5' SAMPLE</u>	Recovered 2 0/2 0' = 100%	<u>3 5-6.3'</u> Field screen reading HNu = 0 0(0 0), OVA = 0 0(0 0)
			CLAY mixed brown and severely oxide stained, much noted claystone fragments and some sandstone particles, fine-grained sand, weakly cemented, fill, moist	<u>0 0 8 5'</u> Composite sample SP11870008
		<u>3 5-6 3' SAMPLE</u>	Recovered 3 2/2.8' = 114%	<u>6 3-8 5'</u> Field screen readings HNu = 0 0(0.0), OVA = 0 0(0 0)
			SANDY CLAYSTONE mixed oxide stained brown, gravel, weakly cemented, low plastic, 1 75 mm fragment of asphalt noted at approximately 5 5'	<u>8 8-11.3'</u> Readings on core HNu = 0, OVA = 13 5
10		<u>6 3 8 8' SAMPLE</u>	Recovered 2 2/2.5' = 88%	<u>8 8-11 3'</u> Direct hit sample SP118708DH
			CLAY oxide stained brown to light gray and dark brown, claystone fragments, sandy to very sandy, fine-grained, weakly cemented, massive, very moist.	<u>11.5-14 0'</u> Readings on core. HNu = 0; OVA = 95
		<u>8 8-11 5' SAMPLE</u>	Recovered 2.5/2 7' = 93%	<u>11.5-14.0'</u> Direct hit sample SP118711DH
			CLAY brown to dusky brown (3 YR 2/2), claystone fragments, very much clay, few roots noted, slightly sandy, small and medium size scattered gravel, weakly cemented, low to medium plastic lenses; very moist	
15		<u>11 5 14 0' SAMPLE</u>	Recovered 2 5/2 5' = 100%	
			CLAY dark gray (N 4/0) to dark gray (N 3/0), claystone fragments and clay with occasional gravel; varying gravel, rounded (1 75 2 50 mm), medium plastic, moderately to weakly cemented, moist to very moist at bottom	
20				

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates _____

Total Depth _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By _____

Geologist

Borehole/Well No SP11-87(cont'd.)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<p>14 0-16 5' SAMPLE Recovered 1 1/2 5' = 44%</p> <p>14 0-14 5' CLAY medium dark gray (N 4/0) to light gray (N 7/0) with some brown, claystone fragments, scattered gravel, slightly oxide stained, weakly cemented; highly plastic, moist</p> <p><u>ROCKY FLATS ALLUVIUM</u></p> <p>14 5-15 1' CLAY grayish black (N 2/0) to brownish black (5 YR 2/2), scattered gravel, subrounded and subangular to 2 75 mm, slightly sandy, fine-grained, slightly organic, low plastic, moist.</p> <p>16 5-19 0' SAMPLE Recovered 1 3/2 5' = 52%</p> <p>16 5-17 0' CLAY brownish black (5 YR 2/2), scattered gravel, same as above</p> <p>17 0-17 8' CLAY moderate yellowish brown (10 YR 5/4) to grayish brown (5 YR 3/2), moderately cemented, medium plastic, slightly sandy and moist</p> <p>19 0-21 5' SAMPLE Recovered 0 5/2 5' = 20%</p> <p>CLAY mixed brown and gray, medium plastic, moderately cemented, slightly sandy, very fine grained, little scattered gravel, moist</p> <p><u>ARAPAHOE FORMATION</u></p> <p>21 5-24 0' SAMPLE Recovered 2 5/2 5' = 100%</p> <p>SANDSTONE medium light gray (N 6/0) to medium dark gray (N 4/0), moderately oxide stained brown, low plastic, fine grained sand (3 0 2 5 0), poorly sorted, somewhat blocky and moist</p> <p>24 0-26 5' SAMPLE Recovered 2 5/2 5' = 100%</p> <p>CLAYEY SANDSTONE noted lignite fragments, gray as noted above, slightly to moderately oxide stained streaks, blocky, massive, low plastic, weakly cemented, fine-grained sand, moist</p>	<p>14 0 15 1' Readings on core HNU = 0, OVA = 95</p> <p>14 0 15 1' Direct hit sample SP118714DH</p> <p>16 5-17,8' Readings on core HNU = 0, OVA = 76</p> <p>16 5-17 8' Direct hit sample SP118716DH</p> <p>19 0-19 5' Readings on core HNU = 0, OVA = 310</p> <p>19 0-19 5' Direct hit/upper contact sample SP118719DH</p> <p>21 5' Readings in augers HNU = 0, OVA = 210</p> <p>21 5 24 0' Readings on core HNU = 1 5, OVA = 98</p> <p>21 5-24 0' Direct hit/contact sample SP118721DH</p> <p>24 0 26 5' Readings on core HNU = 0, OVA = 58</p> <p>24 0-26 5' Direct hit/bedrock sample SP118724DH</p>
25				
30				
35				
40				

LOG
OF
BOREHOLE

Location Rocky Flats Plant; Solar Ponds Area

Coordinates _____

Total Depth _____

Borehole/Well No SP11-87 (cont'd.)

Ground Surface Elevation _____

Water Level Encountered _____

Static

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>26 5-29 0' SAMPLE</u> Recovered 2 5/2 5' = 100% CLAYEY SANDSTONE medium dark gray (N 4/0) to dark gray (N 3/0), severely oxide stained brown streaks, low plastic, massive, somewhat blocky, moist	<u>26 5-29 0'</u> Readings on core HNu = 0, OVA = 38
			<u>29 0 31 5' SAMPLE</u> Recovered 2 5/2.5' = 100% CLAYEY SANDSTONE medium dark gray (N 4/0) with slight oxide staining, lignite particles scattered about, fine-grained sand (3 0 2 5 0), low plastic, massive, weakly to moderately cemented, moist	<u>26 5-29 0'</u> Direct hit sample SP118726DH <u>29 0'</u> Readings in augers HNu = 0, OVA = 220
			<u>31 5-34 0' SAMPLE</u> Recovered 2 5/2 5' = 100% SANDSTONE/CLAYSTONE INTERBED-DED dark gray (N 3/0) varying to medium gray (N 5/0) with slight to moderate oxide stained lenses of light brown (5 YR 5/6), fine grained sand (3 0 2 5 0), massive claystone, low to medium plastic, blocky, poorly sorted sand; moist to light moist at bottom	<u>29 0 31 5'</u> Direct hit sample SP118729DH <u>29 0-31 5'</u> Readings in core HNu = 0, OVA = 11 5
			TOTAL DEPTH 34 0'	<u>31 5-34 0'</u> Field screen readings HNu = 0(0); OVA = 0(0)

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Boring No SP12-87

Completed as well? No

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- ☐ Well Construction Summaries
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- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdriograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area
Coordinates * N 38635 E 21855
Total Depth 46 5'

Borehole/Well No SP12-87
Ground Surface Elevation *5893.0'
Water Level Encountered 39 0'

Drilling Company Bovles Bros.
Date Drilled November 9-11, 1987
Drilling Method Hollow Stem Auger
Logged By R Treat
Geologist

Static _____
Driller T. High
Helper B Keenev
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement
*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
		<u>0 0 1 5' SAMPLE</u>	Recovered 1 0/1 5' = 67% SANDY CLAY moderate yellowish brown (10 YR 5/4) to dark yellowish orange (10 YR 6/6), fine grained sand (2.5-2 0 Ø), poorly sorted, weakly cemented, moist	HNu Background=0.0 OVA Background=0.2 Ludlum Background = 0.0
		<u>1 5 3 5' SAMPLE</u>	Recovered 2 0/2 0' = 100% 1 5 2 0' CLAY moderate brown (5 YR 4/4), slightly sandy, some small-size scattered gravel, rounded, moderately cemented, moist 2 0 3 5' CLAY medium gray (N 5/0) to varying brown of moderate yellowish brown (10 YR 5/4), fine-grained sand, weakly cemented, low plastic, fill, moist	<u>0 0 1 0'</u> Field screen readings HNu = 0 0(0 0), OVA = 0.0(0 0) <u>1 5 3 5'</u> Field screen readings HNu = 0 0(0 0), OVA = 0 0(0 0) <u>3 5-6 5'</u> Field screen readings HNu = 0 0(0 0), OVA = 0 0(0 0)
5		<u>3 5-6 5' SAMPLE</u>	Recovered 3 0/3 0' = 100% 3 5-4 5' CLAY light brown (5 YR 5/6), sandy and scattered gravel, moderately cemented, fine and medium-grained sand (1 5-1 0 Ø to 0 5 0 0 Ø), gravel ranging 1 50 mm, rounded, low plastic, moist 4 5 6 5' CLAY medium gray (N 5/0), low plastic, sandy (3 0-2 5 Ø), weakly cemented, some thin clay pockets, poorly sorted sand, slightly oxide stained, weathered, claystone fragments, moist	<u>0 0-9 0'</u> Composite sample SP12870009 <u>6 5-9 0'</u> Field screen readings HNu = 0 0(0 0), OVA = 0 0(0 0) <u>9 0 11 5'</u> Field screen readings HNu = 0 0(0 0), OVA = 0 0(0 0) <u>11 5-14 0'</u> Field screen readings HNu = 0 0(0 0), OVA = 0 0(0 0)
10		<u>6 5 9 0' SAMPLE</u>	Recovered 2.5/2 5' = 100% SAND AND CLAY very pale orange (10 YR 8/2) to medium light gray (N 6/0) and medium gray (N 5/0), blotchy, weakly cemented, low plastic, moist	<u>14.0-16.5'</u> Field screen readings HNu = 0 0(0 0); OVA = 0.0(0 2)
15		<u>9 0 11 5' SAMPLE</u>	Recovered 2.5/2 5' = 100% CLAY AND SAND moderate yellowish brown (10 YR 5/4) to dark gray (N 3/0) to medium light gray (N 6/0), noted 0 4' lense of clayey sand at approximately 10 8-11 2' with gravel, low plastic, weakly cemented, fine and medium-grained sand lenses, moist	<u>9 0-16.5'</u> Composite sample SP12870916
20				

LOG
OF
BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Borehole/Well No SP12-87(cont'd)

Coordinates _____

Ground Surface Elevation _____

Total Depth _____

Water Level Encountered _____

Static

Drilling Company _____

Driller _____

Date Drilled _____

Halber

Drilling Method _____

Drilling Fluid _____

Logged By

Checked By _____

Geologist

Checked By _____

Site Manager

CEARP Manager

Comments

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<p><u>11 5-14 0' SAMPLE</u> Recovered 2.5/2.5' = 100% CLAY grayish brown (5 YR 3/2) to dark yellowish brown (10 YR 5/4), small (1 50 mm) gravel, rounded, claystone fragments medium dark gray (M 4/0), low plastic, weakly to moderately cemented, scattered gravels and claystone, moist</p>	
25			<p><u>14 0-16 5' SAMPLE</u> Recovered 3.2/2 5' = 128% CLAY some claystone lenses, as noted above for colors with small and medium scattered gravel (1 25 mm to 3 4 mm), rounded, subrounded, and subangular, slightly sandy, moderate to low plasticity, few scattered roots noted, moist</p>	
			<p><u>16 5-19 0' SAMPLE</u> Recovered 2 5/2 5' = 100% CLAY mixed brown to varying gray, with claystone fragments, scattered gravel, slightly to moderately oxide stained, medium to low plastic, slightly sandy to sandy lenses, fine- and medium grained, moist</p>	<p><u>16 5-19 0'</u> Readings on core HNU = 0, OVA = 6.8</p>
30			<p><u>19 0-21 5' SAMPLE</u> Recovered 2 5/2 5' = 100% CLAY multi-colored brown and gray, with some claystone fragments, noted organic lense at 21 0 21 4', dusky brown (5 YR 2/2), numerous roots, low to medium plastic, weakly cemented, light moist to moist</p>	<p><u>16 5-19 0'</u> Direct hit sample SP128716DH</p> <p><u>19 0-21 5'</u> Readings on core HNU = 6.8, OVA = 132</p>
			<p><u>21 5-24 0' SAMPLE</u> Recovered 2.5/2 5' = 100% 21 5 21 8' CLAY varying brown, medium and large-size gravel (3 50 mm), moist</p>	<p><u>19 0-21 5'</u> Direct hit sample SP128719DH</p> <p><u>21 5-24 0'</u> Readings on core HNU = 0, OVA = 76</p>
35			<p><u>ROCKY FLATS ALLUVIUM</u></p> <p>21 8 24 0' CLAY dusky brown (5 YR 2/2) to brownish black (5 YR 2/2), scattered gravel (1 50 mm), rounded and subrounded, much roots noted, low plastic, sand (3 5 3 0 0), light moist to moist</p>	<p><u>21 5-24 0'</u> Direct hit sample SP128721DH</p>
40				

LOG
OF
BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Borough/Well No. SP12-87(cont'd)

Coordinates _____

Ground Surface Elevation _____

Total Depth _____

Water Level Encountered _____

Static

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
40			<p><u>24 0 26 5' SAMPLE</u> Recovered 1 2/2 5' = 48% SAND moderate yellowish brown (10 YR 5/4) to light brown (5 YR 5/6) and little dark yellowish orange (10 YR 6/6), slightly clayey to very clayey with gravel, well sorted sand ranging (2 0 1 5 Ø to 0 5 1 0 Ø), subrounded, rounded, and few subangular gravels ranging 1 25 mm to 3 75 mm and larger, weakly cemented, light moist</p>	<p><u>24 0-25 2'</u> Readings on core HNU = 0, OVA = 124</p>
45			<p><u>26 5-29 0' SAMPLE</u> Recovered 0.8/2 5' = 32% CLAY varying brown to medium gray (N 5/0), slightly sandy with small scattered gravels, medium plastic, slightly calcareous, moderately plastic, moist</p>	<p><u>24 0 25 2'</u> Direct hit sample SP128724DH</p>
			<p><u>29 0 31 5' SAMPLE</u> Recovered 2 5/2 5' = 100% 29 0 29 7' SANDY CLAY pale brown (5 YR 5/2) to moderate yellowish brown (10 YR 5/4), slightly oxide stained, fine-grained sand (3.0 2.5 Ø), weakly cemented, low plastic, light moist</p>	<p><u>26.5-27 3'</u> Direct hit/upper contact sample SP128726DH</p>
50			<p><u>ARAPAHOE FORMATION</u></p>	<p><u>29 0 31 5'</u> Readings on core HNU = 0, OVA = 38</p>
			<p>29 7 31.5' SANDY CLAYSTONE medium light gray (N 6/0) to medium dark gray (N 4/0), fine-grained sand (3.5 3 0 Ø), massive, blocky, low plastic, weakly to somewhat moderately cemented, weathered, moist</p>	<p><u>29 0-31 5'</u> Direct hit/contact sample SP128729DH</p>
			<p><u>31 5-34 0' SAMPLE</u> Recovered 0 7/2 5' = 28% CLAYSTONE medium gray (N 5/0) to dark gray (N 3/0), medium plastic; slightly oxide stained, massive, slightly sandy, weathered, moist</p>	<p><u>31 5 32 2'</u> Readings on core HNU = 0, OVA = 72</p>
55			<p><u>34 0-36 5' SAMPLE</u> Recovered 0 5/2 5' = 20% SANDY CLAYSTONE same as above</p>	<p><u>31 5 32 2'</u> Direct hit/bedrock sample SP128731DH</p>
			<p><u>36 5 39 0' SAMPLE</u> Recovered 0 0/2 5' = 0%</p>	<p><u>34 0-34 5'</u> Readings on core HNU = 0, OVA = 78</p>
60				<p><u>34 0 34 5'</u> Direct hit sample SP128734DH</p>
				<p><u>39 0-41 0'</u> Readings on core HNU = 0, OVA = 22</p>

LOG
OF
BOREHOLE

Location Rocky Flats Plant: Solar Ponds Area

Coordinates _____

Total Depth _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By

Geologist

Borehole/Well No SP12-87 (cont'd.)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>39 0-41 0' SAMPLE.</u> Recovered 2.0/2 0' = 100% SANDSTONE medium dark gray (N 4/0) to dark gray (N 3/0), slightly oxide streaked, much lignite influence, fine-grained sand (3 0 2.5 Ø), weakly cemented, weathered, light moist</p> <p><u>41 5-44 0' SAMPLE</u> Recovered 2.5/2 5' = 100% SANDSTONE varying pale brown (5 YR 5/2) to grayish brown (5 YR 3/2) to dark gray (N 3/0), now only moderately influenced with lignite seams, slightly oxide stained, fine-grained sand, weakly to moderately cemented, weathered, light moist</p> <p><u>44 0-46 5' SAMPLE</u> Recovered 2 5/2 5' = 100% SANDSTONE clayey pale brown (5 YR 5/2) to grayish brown (5 YR 3/2), weakly to moderately cemented, fine-grained sand (3 5 3 0 Ø and 3 0 2 5 Ø), poorly sorted, weathered, light moist</p> <p style="text-align: center;">TOTAL DEPTH 46 5'</p>	<p><u>39 0-41 0'</u> Direct hit sample SP128739DH</p> <p><u>41 5-44 0'</u> Readings on core HNu = 0, OVA = 8 8</p> <p><u>41 5-44 0'</u> Direct hit sample SP128741DH</p> <p><u>44 0-46.5'</u> Readings on core. HNu = 0, OVA = 0</p> <p><u>44 0 46 5'</u> Field screen readings. HNu = 0 0(0 0), OVA = 0.0(0 0)</p>

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Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydiograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates * N 38350 E 22120

Total Depth 16.5'

Borehole/Well No SP13-87

Ground Surface Elevation *5925.0'

Water Level Encountered None

Static

Drilling Company Boyles Bros.

Date Drilled November 6, 1987

Drilling Method Hollow Stem Auger

Logged By R Treat

Geologist

Driller T. High

Helper B Keeney

Drilling Fluid None

Checked By

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement

*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
		0 0-1 5' SAMPLE	Recovered 1 5/1 5' = 100%	
		0 0-1 3' SAND	grayish orange (10 YR 7/4), silty and slightly clayey, fine-grained sand (3 5 3.0 Ø); weakly cemented, poorly sorted with upper 0 2' organic with many roots noted, light moist	
			<u>ROCKY FLATS ALLUVIUM</u>	
5		1 3 1 5' CLAY	grayish brown (5 YR 3/2), moderately cemented, medium plastic, some scattered gravel, lightly moist	HNu Background=0.8 OVA Background=3.2 Ludlum Background = 0 0
		1 5-3 5' SAMPLE	Recovered 2 0/2.0' = 100%	
		1 5 2 7' CLAY	grayish brown (5 YR 3/2), moderately to highly cemented, medium plastic, slightly sandy, very fine grained, moist	0 0-1 5' Upper contact sample SP138700UC
			<u>ARAPAHOE FORMATION</u>	1 5 3 5' Contact sample taken SP138701CT
10		2 7 3.5' SANDY CLAYSTONE	medium light gray (N 6/0), low plastic, massive, blocky, fine-grained sand (3.5-3.0 Ø), weathered, moist	3 5-6 5' Bedrock sample taken SP138703BR
		3 5-6 5' SAMPLE	Recovered 3 0/3 0' = 100%	6 5-9 0' Direct hit sample SP138706DH
		SANDY CLAYSTONE	medium dark gray (N 4/0), fine grained sand (3 5 3 0 Ø), massive, just slightly oxide stained, blocky, medium plastic, moderately cemented; weathered, moist	6 5-9 0' Duplicate sample SP13876DUP
15		6 5-9.0' SAMPLE	Recovered 2 5/2.5' = 100%	9 0-11 5' Direct hit sample. SP138709DH
		CLAYSTONE	sandy to very sandy as noted in previous run, medium to low plastic, weakly cemented, slightly to moderately oxide stained, weathered, moist	
		9 0-11 5' SAMPLE	Recovered 2 5/2.5' = 100%	
		9 0 9 2' SANDY CLAYSTONE	as noted above	
		9 2-11 5' CLAYEY SANDSTONE	medium light gray (N 6/0) to moderately and severely oxide stained brown of dark yellowish orange (10 YR 6/6) to moderate yellowish brown (10 YR 5/4), weakly to moderately cemented, fine-grained sand (3 0 2 5 Ø), poorly sorted, weathered, moist	
20				

LOG
OF
BOREHOLE

Location Rocky Flats Plant: Solar Ponds Area **Borehole/Well No** SP13-87 (cont'd.)

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller

Hoibor

Drilling Fluid _____

Checked By

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>11 5 14 0' SAMPLE</u> Recovered 2.5/2 5' = 100% 11 5-13 5' SANDSTONE clayey to very clayey lenses, color as stated above, fine-grained sand (3 0-2 5 Ø), weakly cemented, moderately oxide stained, moist, 13 5 14 0' CLAYSTONE medium dark gray (N 4/0), slightly sandy, massive, medium plastic, blocky, fine-grained sand, poorly sorted, weathered, light moist</p> <p><u>14 0-16 5' SAMPLE</u> Recovered 2 5/2 5' = 100% CLAYSTONE medium gray (N 5/0) to medium dark gray (N 4/0), slightly sandy to sandy lensed, only slight oxide staining apparent, pale yellowish orange (10 YR 8/6), blocky, massive, weathered, moist</p> <p>TOTAL DEPTH 16 5'</p>	<p><u>11 5 14 0'</u> Direct hit sample SP138711DH</p> <p><u>14 2'</u> Readings in augers HNu = 14 2' OVA = 0 0</p> <p><u>14 0 16 5'</u> Field screen readings HNu = 0 0(0 0), OVA = 0 0(0 0)</p>

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Completed as well? No

Data in File

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- Well Construction Summaries
- Well Development Summaries
- Hydraulic Conductivity Test Data
and Results
- Packer Test Data and Results
- Water Level Data
- Saturated Thickness Hvdriograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates * N 38622 E 22328

Total Depth 7 0'

Borehole/Well No SP14-87

Ground Surface Elevation *5890.0'

Water Level Encountered None

Static

Drilling Company Bovles Bros

Date Drilled November 11 and 12, 1987

Drilling Method Hollow Stem Auger

Logged By R Treat

Geologist

Driller T. High

Helper B Keeney

Drilling Fluid None

Checked By

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement

*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
			<u>0 0 2 0' SAMPLE</u> Recovered 0 4/2 0' = 20% CLAY dusky brown (5 YR 2/2), slightly sandy with gravel, low plastic, weakly cemented, moist, very organic in upper 0 4', with roots	
			<u>2 0-4 0' SAMPLE</u> Recovered 2.0/2 0' = 100% 2 0 3.2' CLAY dark yellowish orange (10 YR 6/6) to moderate yellowish brown (10 YR 5/4), low to medium plastic, scattered gravel, moderately cemented, moist	
5			<u>ARAPAHOE FORMATION</u>	
			3 2-4 0' CLAYSTONE AND SANDSTONE medium dark gray (N 4/0) to dark gray (N 3/0), weakly cemented, poorly sorted, fine grained sand (3 0 2 5 0), low plastic, weathered, light moist	HNu Background=1 1 OVA Background=0.0 Ludlum Background = 0 0 0.0-0 4' Upper contact sample SP148700UC (VOAs only)
			<u>4 0 7 0' SAMPLE</u> Recovered 3.0/3 0' = 100% SANDY CLAYSTONE medium dark gray (N 4/0), medium plastic, blocky, slightly oxide stained, streaked and slightly calcareous lensed, massive, fine- grained sand (3.5 3 0 0), weakly to moderately cemented, weathered, moist	0 0 0 4' Field screen readings HNu = 0 0(0 0), OVA = 0.0(0 0) 2 0 4 0' Contact sample SP148702CT
10				4 0-7 0' Bedrock sample taken SP148704BR.
			TOTAL DEPTH 7 0'	
15				
20				

INDEX OF DATA

Boring No SP15-87

Completed as well? No

Data in File

- ☒ Log of Borehole
- ☐ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdiograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Ponds Area

Coordinates * N 38273 E 22674

Total Depth 19.5'

Borehole/Well No SP15-87

Ground Surface Elevation *5927.0'

Water Level Encountered 12 3'

Static

Drilling Company Bovles Bros.

Driller T High

Date Drilled November 12 and 13, 1987

Helper B Keenev

Drilling Method Hollow Stem Auger

Drilling Fluid None

Logged By R Treat

Checked By

Geologist

Site Manager

CEARP Manager

Comments Borehole backfilled with Portland Type I Cement

*Coordinates and elevation estimated from topographic map

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL/DISTURBED</u>	
			<u>0 0-2 0' SAMPLE</u> Recovered 1 5/2 0' = 75% CLAY dark yellowish orange (10 YR 6/6) to moderate brown (5 YR 4/4) and light brown (5 YR 5/6) to medium gray (N 5/0), claystone pieces, sandy with scattered gravel, rounded and subrounded, quartzite composition, low plastic, weakly cemented, light moist to moist lensed	HNu Background=0.0 OVA Background=0.0 Ludlum Background = 0 0 <u>0 0-1 5' Field screen</u> readings HNu = 0 0(0 0), OVA = 2.2(2.7)
5			<u>2 0-4 0' SAMPLE</u> Recovered 0.8/2 0' = 40% CLAY with claystone and sandstone, colors varying as stated above with scattered gravel, weakly cemented, fine-grained sand, light moist	<u>2 0-2 8' Direct hit</u> sample SP158702DH. <u>2 0-2 8' Readings on</u> core HNu = 0, OVA = 12 5
			<u>4 0-7 0' SAMPLE</u> Recovered 0 4/3 0' = 13% CLAY with claystone and some scattered gravel, multi-colored brown to gray, low plastic, weakly cemented, subrounded and rounded gravel, light moist	<u>4 0-4 4' Readings on</u> core HNu = 0, OVA = 4 85 <u>4 0-4 4' Direct hit</u> sample SP158704DH (VOAs only)
10			<u>7 0-8 0' No recovery Drilled with center bit</u>	
			<u>8 0-10 0' SAMPLE</u> Recovered 2 0/2.0' = 100% CLAY light brown (5 YR 6/4) to moderate yellowish brown (10 YR 5/4) and grayish brown (5 YR 3/2), slightly sandy to very sandy lensed, fine-grained sand (3 5-3 0 0); weakly to moderately cemented, low to medium plastic, scattered gravel to 2.75 mm, rounded, soil very organic in composition and smell, moist	<u>8 0-10 0' Readings on</u> core HNu = 0, OVA = 44 <u>8 0-10.0' Direct hit</u> sample SP158708DH <u>8 0-10.0' Duplicate</u> sample SP15870080.
			<u>ROCKY FLATS ALLUVIUM</u>	
15			<u>10 0-12 0' SAMPLE</u> Recovered 2 0/2 0' = 100% 10 0-10 5' CLAYEY SAND light brown (5 YR 5/6), scattered gravel, fine-grained sand (2 5 2 0 0 to 2 0-1 5 0), rounded gravel, weakly cemented, moist 10 5-11 5' CLAY light gray (N 7/0) to light olive gray (5 Y 5/2) and pale brown (5 YR 5/2), slightly organic, moderately cemented, moist 11 5-12.0' CLAY very sandy, moderate brown (5 YR 4/4) to moderate yellowish brown (10 YR 5/4), fine-grained sand (3 5-3 0 0), moderately cemented, low plastic; moist	<u>10 0-12 0' Readings on</u> core HNu = 0, OVA = 28 <u>10 0-12 0' Direct hit</u> sample SP158710DH <u>12.0' Readings in</u> augers HNu = 0, OVA = 2 2
20				

LOG OF BOREHOLE

Location Rocky Flats Plant; Solar Ponds Area

Borehole/Well No SP15-87 (cont'd.)

Coordinates _____

Ground Surface Elevation _____

Total Depth _____

Water Level Encountered _____

Static _____

Drilling Company _____

Driller _____

Date Drilled _____

Helper _____

Drilling Method _____

Drilling Fluid _____

Logged By _____

Checked By _____

Geologist

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>12 0 14 5' SAMPLE</u> Recovered 2 5/2 5' = 100% SAND moderate yellowish brown (10 YR 5/4) to dark yellowish orange (10 YR 6/6) to light gray (N 7/0) and medium gray (N 5/0), streaked, slightly clayey to very clayey, sand (2 5 2 0 0), weakly cemented, wet approximately 12 0 12 3', then very moist</p>	<p><u>12 0-14 5'</u> Readings on core: HNU = 0, OVA = 2.2</p>
			<p><u>14 5-17 0' SAMPLE</u> Recovered 2 5/2 5' = 100% 14 5 14 9' SAND very clayey as noted in previous run</p>	<p><u>12 0 14 5'</u> Water table, upper contact; direct hit sample SP158712MT</p>
			<p style="text-align: center;"><u>ARAPAHOE FORMATION</u></p>	
			<p>14 9 17 0' SANDY CLAYSTONE light brown (5 YR 5/6) to predominantly medium light gray (N 6/0), weathered, moderately oxide stained, medium plastic, massive, fine-grained sand (3 5-3 0 0), blocky, weakly to moderately cemented, moist</p>	<p><u>14 5 17 0'</u> Contact sample SP158714CT</p>
			<p><u>17 0 19 5' SAMPLE</u> Recovered 2 5/2 5' = 100% CLAYSTONE medium light gray (N 6/0) to medium dark gray (N 4/0), weathered, sandy (3 5 3 0 0), blocky, massive, medium plastic, moderately cemented; moist</p>	<p><u>17 0 19 5'</u> Bedrock sample SP158717BR</p>
			<p style="text-align: center;">TOTAL DEPTH 19 5'</p>	

INDEX OF DATA

Boring No 56-87/SP16-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdriograph

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Pond Area
Coordinates N 37654.23 E 21319.10
Total Depth 13.40'

Borehole/Well No 56-87/SP16-87
Ground Surface Elevation 5978.51'
Water Level Encountered None

Drilling Company Boyles Bros
Date Drilled January 7, 1988
Drilling Method Hollow Stem Auger
Logged By KD Hollaway
Geologist

Static _____
Driller T High
Helper B Keeney
Drilling Fluid None
Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>TOP SOIL</u>	HNu background=12 OVA Background=16 Ludlum background = 00
			<u>0.0-2.0 SAMPLE</u> Recovered 20/20 = 100%	
			00-05 TOP SOIL varied greens and browns, grass and ice, subangular, cobbles up to 1" diameter, sandy clay, frozen	
5			<u>ARTIFICIAL FILL/DISTURBED</u>	<u>0.0-2.0</u> Field screen readings HNu = 12 (12), OVA = 19 (12)
			05-11' CLAYEY SAND pale yellowish brown (10 YR 6/2) to dark yellowish brown (10 YR 4/2), very coarse-grained (20-15 Ø to 1/4"), poorly sorted sand, subrounded to angular, small quartzite gravel up to 1" diameter, unconsolidated, moist to frozen	<u>0.0-2.0'</u> Field screen sample SP168702FS
10			11-20' SANDY CLAY moderate brown (5 YR 3/4), some very coarse-grained, poorly sorted, subrounded to angular sand, angular quartzite gravel up to 3" diameter, varied green to yellow red orange to red staining throughout core, damp	<u>2.0-3.5'</u> Field screen readings HNu = 12 (12), OVA = 12 (12)
15				<u>4.0-6.0'</u> Field screen readings HNu = 16 (16), OVA = 12 (12)
				<u>6.0-8.0'</u> Field screen readings HNu = 12 (12), OVA = 10 (10)
				<u>6.0-8.0'</u> Upper con- tact sample SP168708UC
				<u>10.0-11.2</u> Contact sample SP168710CT
20				<u>11.2-13.4</u> Field screen readings HNu = 12 (12), OVA = 10 (10)

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Pond Area
Coordinates N 37654 23 E 21319.10
Total Depth 13.40'

Borehole/Well No 56-87/SP16-87 (cont'd.)
Ground Surface Elevation 5978.51'
Water Level Encountered None

Drilling Company Boyles Bros
Date Drilled January 7, 1988
Drilling Method Hollow Stem Auger
Logged By KD Hollaway
Geologist

Static _____
Driller T. High
Helper B. Keeney
Drilling Fluid None
Checked By _____
Site Manager
CEAMP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>20-40' SAMPLE</u> Recovered 15/20' = 75% CLAYEY SAND AND GRAVEL light brown (5 YR 5/6) with pale yellowish orange (10 YR 8/6) and dark yellowish orange (10 YR 6/6) with trace moderate reddish brown (10 YR 4/6), mostly in sand zones, very coarse-grained, poorly sorted sand, subangular to angular, quartzite gravel subangular to broken, to 3" diameter, becomes sandier down core with medium-grained (2.5-1.5 Ø) fairly sorted, subangular sand, damp</p> <p><u>40-60 SAMPLE</u> Recovered 20/20' = 100% SANDY CLAY moderate yellowish brown (10 YR 5/4) to dark yellowish brown (10 YR 4/2) with some yellowish gray (5 Y 7/2) especially towards bottom of core, subangular to angular quartzite gravel up to 2" diameter increases down core, quartzitic sand and pebbles, sub-rounded to subangular medium-grained (2.0-1.5 Ø) to coarse-grained up to 1/4" diameter, poorly sorted, unconsolidated, some caliche increases down core, damp to moist</p>	<p><u>11.2-13.4' Bedrock</u> Sample SP168711BR</p>

LOG OF BOREHOLE

Location Rocky Flats Plant, Solar Pond Area
 Coordinates N 37654.23 E 21319 10
 Total Depth 13.40'

Borehole/Well No 56-87/SP16-87 (cont'd.)
 Ground Surface Elevation 5978 51'
 Water Level Encountered None

Drilling Company Boyles Bros
 Date Drilled January 7, 1988
 Drilling Method Hollow Stem Auger
 Logged By KD Hollaway
 Geologist

Static _____
 Driller T High
 Helper B Keeney
 Drilling Fluid None
 Checked By _____
 Site Manager
 CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>60-80' SAMPLE</u> Recovered 20/20' = 100% 60-63' GRAVEL angular to broken, some fine-grained sand, dry 63-70' CLAYEY SAND dusky yellow (5 Y 6/4) to yellowish gray (5 Y 7/2), some clay, sand is very fine-grained to fine- grained (25-20 Ø), fairly well sorted, unconsolidated, some caliche (strong reaction to HCl), damp to moist 700-800 CLAYEY SAND AND GRAVEL yellowish gray (5 Y 7/2) with light brown (5 YR 5/6) and moderate reddish brown (10 R 4/6) staining, fine- grained (25-20 Ø) to coarse-grained, poorly sorted, subrounded to subangular sand, subangular gravel, lots of caliche, unconsolidated, moist	
			<u>80-100' SAMPLE</u> Recovered 00/20' = 0% Lost core	
			<u>ARAPAHOE FORMATION</u> Q/Ka contact estimated at 940' by drilling and cuttings	
			<u>100-112' SAMPLE</u> Recovered 18/12' = 150% SANDY CLAYSTONE light olive gray (5 Y 5/2) to yellowish gray (5 Y 7/2) with dark yellowish orange (10 YR 6/6) iron staining, very fine-grained to fine- grained sand, some caliche, consolidated, damp	

LOG
OF
BOREHOLE

Location Rocky Flats Plant, Solar Pond Area
Coordinates N 37654 23 E 21319.10
Total Depth 13.40'

Borehole/Well No 56-87/SP16-87 (cont'd.)

Ground Surface Elevation 5978.51'

Water Level Encountered None

Static _____

Drilling Company Boyles Bros

Driller T High

Date Drilled January 7, 1988

Helper B Keeney

Drilling Method Hollow Stem Auger

Drilling Fluid None

Logged By KD Hollaway

Checked By _____

Geologist

Site Manager

GEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>11.2-13.4' SAMPLE.</u> Recovered 2 2/2 2' = 100% SANDY CLAYSTONE same as above with occasional iron nodules</p> <p>TOTAL DEPTH 13 40'</p>	

INDEX OF DATA

Boring No 9-87/BH29-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hydrograph

LOG OF BOREHOLE

Location Rocky Flats Plant; 903 Pad Area
Coordinates N 36080.84 T 22239.33
Total Depth 37.50'

Borehole/Well No 9-87BR/BH29-87
Ground Surface Elevation 5980.22'
Water Level Encountered 17.50'
Static 5963.42' (12/01/87)

Drilling Company Boyles Bros
Date Drilled June 12, 1987
Drilling Method Hollow Stem Auger
Logged By J. B. Bergman
Geologist

Driller R. Sharp
Helper T. Merritt
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			TOPSOIL	HNu Background=0.6 OVA Background=0.8 No readings over background
			<u>0.0-1.5' SAMPLE</u> Recovered 1.45/1.5' = 76% 0.0 - 0.5' TOP SOIL grayish brown (5 YR 3/2), abundant roots and grasses, sandy clay and gravel, unconsolidated, dry	<u>0.0-10.0' Composite sample BH29870010</u>
5			ROCKY FLATS ALLUVIUM	<u>5.0' Field screen readings HNu = 0.8 (BG), OVA = 1.8 (BG)</u>
			0.5 - 1.45' COBBLES AND GRAVEL pink and gray quartzite and granite in a clay matrix, pale yellowish brown (10 YR 6/2), unconsolidated, angular, dry	<u>9.70-12.70' Contact sample BH298713CT</u>
10			<u>1.5-3.0' SAMPLE</u> Recovered 1.65/1.5' = 110% CLAYEY GRAVEL pink and gray granite and quartzite in a moderate yellowish brown (10 YR 5/4) matrix, sandy, unconsolidated, unsorted, dry	<u>10.0' Field screen readings HNu = 0.8 (BG), OVA = 1.8 (BG)</u>
			<u>3.0-4.2' SAMPLE</u> Recovered 1.0/1.2' = 83% CLAYEY GRAVEL same as above, dry	<u>15.0' Field screen readings HNu = 0.8 (BG), OVA = 1.8 (BG)</u>
15			<u>4.2-5.0' SAMPLE</u> Recovered 1.5/0.8' = 188% CLAYEY GRAVEL same as above, dry	<u>15.70-16.80' Bedrock sample BH298716BR</u>
			<u>5.0-6.0' No recovery Lost core</u>	<u>17.50-18.50' Water table sample BH298717WT</u>
20			<u>6.0-7.5' SAMPLE</u> Recovered 0.6/1.5' = 40% SILT pale yellowish brown (10 YR 6/2), quartzite cobble, distorted sample (cuttings from center bit), dry	<u>20.0' Field screen readings HNu = 0.2 (BG), OVA = 1.8 (BG)</u>

LOG
OF
BOREHOLE

Location Rocky Flats Plant; 903 Pad Area
Coordinates N 36080.84 22239 33
Total Depth 37 50'

Borehole/Well No 9-87BR/BH29-87
Ground Surface Elevation 5980 22'
Water Level Encountered 17 50'
Static 5963.42' (12/01/87)

Drilling Company Boyles Bros
Date Drilled June 12, 1987
Drilling Method Hollow Stem Auger
Logged By J B. Bergman
Geologist

Driller R. Sharp
Helper T Merritt
Drilling Fluid None
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>7.5-9.5' SAMPLE</u> Recovered 20/20' = 100% SAND AND GRAVEL moderate yellowish brown (10 YR 5/4), abundant quartzite and granite, unconsolidated, medium-grained sand, angular to sub-rounded, dry	
25			<u>9.5-12.5' SAMPLE</u> Recovered 20/30' = 67% SAND AND GRAVEL same as above, moist	<u>25.0'</u> Field screen readings HNu = 02 (BG), OVA = 18 (BG)
			<u>12.5-15.0' SAMPLE</u> Recovered 20/25' = 80% 12.5-12.7' SAND AND GRAVEL same as above, moist	
30			<u>ARAPAHOE FORMATION</u> 12.7-13.8' SANDSTONE light brown (5 YR 6/4), very fine grained, rounded, well sorted, wet 13.8-14.5' SANDSTONE pale yellowish brown (10 YR 6/2), quartzose, coarse grained, well sorted, rounded, moist	<u>30.0'</u> Field screen readings HNu = 02 (BG), OVA = 18 (BG)
35			<u>15.0-17.5' SAMPLE</u> Recovered 18/25' = 72% SANDSTONE yellowish grav (5 Y 8/1), well sorted, medium grained, consolidated, moist	<u>35.0'</u> Field screen readings HNu = 02 (BG), OVA = 18 (BG)
40			<u>17.5-20.0' SAMPLE</u> Recovered 20/25' = 80% SANDSTONE same as above, wet at 17.5', clay layer olive gray (5 Y 3/2) at 18.0-18.5', wet	

INDEX OF DATA

Boring No 51-87/BH62-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdriograph

LOG
OF
BOREHOLE

Coordinates _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By _____

Borehole/Well No 5-37/BH62-37

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Helper _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>6.0-8.0 SAMPLE</u> Recovered 20/20' = 100% CLAY varving brown to grayish brown, claystone fragments slightly sandy with scattered gravel 100 mm up to 25 mm, rounded and subrounded, weakly cemented, medium plastic, moist	<u>6.0-8.0'</u> Field screen readings HNu = 02 (04), OVA = 00 (00)
			<u>8.0-10.0' SAMPLE</u> Recovered 00/20' = 0% CLAY same as above	
			<u>10.0-12.0' SAMPLE</u> Recovered 00/20' = 0% Cuttings described CLAY WITH CLAY- STONE FRAGMENTS same as above	
			<u>12.0-12.5' SAMPLE</u> No recovery Drilled with center bit	
			<u>12.5-14.0' SAMPLE</u> Recovered 15/15' = 100% 12.5-13.5' CLAY AND GRAVEL varving gray and brown, claystone fragments with clay and some scattered gravel, weakly cemented, moist	<u>12.5-14.0'</u> Contact sample BH628712CT
			<u>ARAPAHOE FORMATION</u> 13.5-14.0' CLAYSTONE dark gray (N 3/0), massive, blocky, medium plastic weathered, moist	

LOG OF BOREHOLE

Location <u>Rock Flats Plant, 881 Hillside Area</u>	Borehole/Well No <u>51-87/BH62-87</u>
Coordinates <u>N 35120 00 E 20738 10</u>	Ground Surface Elevation <u>5963.30'</u>
Total Depth <u>18.00'</u>	Water Level Encountered <u>12 00'</u>
	Static <u>5948 76' 2/4/88</u>
Drilling Company <u>Bovles Bros</u>	Driller <u>S Bradfield</u>
Date Drilled <u>October 21, 1987</u>	Helper <u>P Mesa</u>
Drilling Method <u>Hollow Stem Auger</u>	Drilling Fluid <u>None</u>
Logged By <u>R.T. Treat</u>	Checked By _____
Geologist	Site Manager
	CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			<u>ARTIFICIAL FILL</u>	
			<u>0 0-2 0' SAMPLE</u> Recovered 0 8/2 0' = 40%	HNu background=0 2 OVA background=0 4 Ludlum readings taken and no readings over background, on core
			<u>0 0-0 5' ASPHALT SURFACING</u> <u>0 5-0 8' SAND AND GRAVEL</u> varving browns, weakly cemented, medium- and coarse-grained sands with small and medium size gravels ranging 0 25 mm up to 3 25 mm, rounded and subrounded, moist (most soils man made fill appearing as a base for asphalt surface)	Field screen readings sample reading (field screen reading)
5			<u>2 0-4 0' SAMPLE</u> Recovered 1 5/2 0' = 75%	<u>0 0-0 8' Field screen</u> readings HNu = 0 0 (0 0), OVA = 0 0 (0 0)
			<u>2 0-2 5' SAND AND GRAVEL</u> same as above	<u>0 0-8 0' Composite</u> sample BH62870008 Duplicate sample BH6287008D
10			<u>ROCKY FLATS ALLUVIUM</u> <u>(DISTURBED)</u>	
			<u>2 5-3 5' CLAY WITH SOME CLAY-</u> <u>STONE FRAGMENTS</u> grayish brown (5 YR 3/2) to moderate reddish brown (10 R 4/6), sandy with scattered gravels, moderately cemented, moist	<u>2 0-3 5' Field screen</u> readings HNu = 0 0 (0 0), OVA = 0 0 (0 0)
15			<u>4 0-6 0' SAMPLE</u> Recovered 1 5/2 0' = 75%	<u>4 0-5 5' Field screen</u> readings HNu = 0 0 (0 0), OVA = (0 0 (0 0)
			<u>CLAY</u> varying gray to reddish browns, slightly sandy, fine-grained (2 5-2 00), few scattered gravels, weakly cemented, poorly sorted, moist	
20				

LOG
OF
BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Borehole/Well No 51-87/BH62-87
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
 Site Manager

 CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>140-160 SAMPLE</u> Recovered 20/20' = 100% CLAYSTONE dark gray (N 3,0), blocky, medium plastic oxide stained in thin streaks weathered, moist	<u>140-160'</u> Bedrock sample BH628714BR
			<u>160-180' SAMPLE</u> Recovered 20/20' = 100% CLAYSTONE same as above, weathered, moist	<u>160-180'</u> Field screen readings HNu = 00 (00), OVA = 00 (00)
			TOTAL DEPTH 1800'	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, 881 Hillside Area

Well No 51-87/BH62-87

Coordinates N 35120 00 E 20738 10

Elevation Ground Surface 5963 30'

Total Depth Well 14.08'

Top of Casing _____

Borehole 18.00'

Formation of Completion Rocky Flats Alluvium

Casing Material Sch 5, Type 316 TFJ stainless steel

Casing Diameter 2" ID

Screen Material 0.010" wire wrap Type 316 TFJ stainless steel

Surface Casing Diameter 5" ID

Date Installed October 22, 1987

Approved By _____

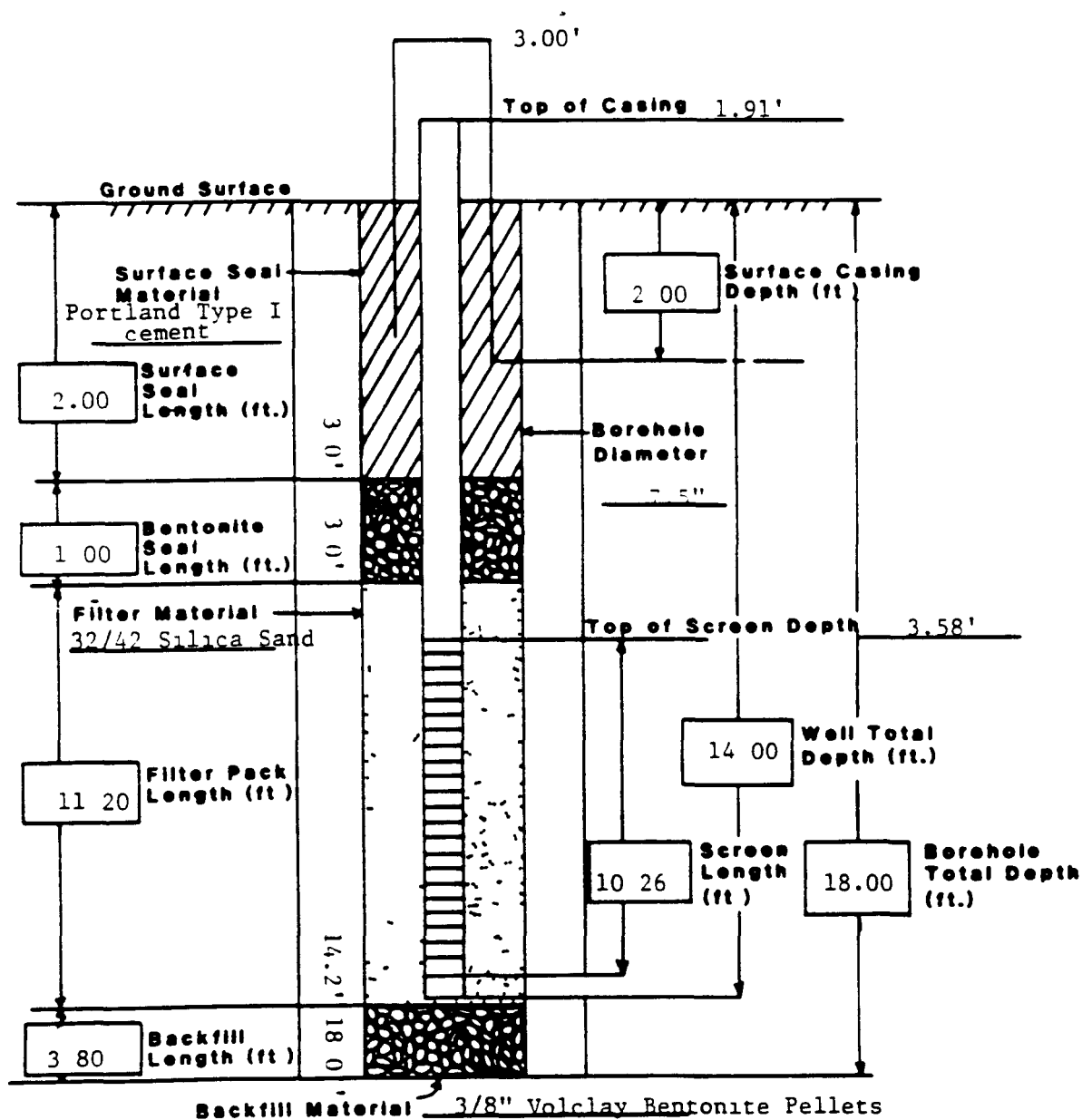
Installed By R.T. Trear

Site Manager

Geologist

CEARP Manager

Comments _____



INDEX OF DATA

Boring No 52-87/BH63-87

Completed as well? Yes

Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data
- ☐ Saturated Thickness Hvdriograph

LOG OF BOREHOLE

Location Rocky Flats Plant, 881 Hillside Area Borehole/Well No 52-87/BH63-27
 Coordinates N 35161.94 T 20954.54 Ground Surface Elevation 5967.57'
 Total Depth 28.00' Water Level Encountered 15.2'
 Static _____
 Drilling Company Boyles Bros. Driller S. Bradfield
 Date Drilled October 16 & 19, 1987 Helper P. Mesa
 Drilling Method Hollow Stem Auger Drilling Fluid None
 Logged By R.T. Treat Checked By _____
 Geologist _____ Site Manager _____
 CEAMP Manager _____

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			ARTIFICIAL FILL	
			<u>00-2.0' SAMPLE</u> Recovered 16/20' = 80%	HNu background=0.2 OVA background=2.4 No Ludlum readings over background along core samples recovered
			<u>00-14' CLAY</u> varying browns, sandy to very sandy with gravel and noted roots, slightly calcareous, slightly moist	
5			ROCKY FLATS ALLUVIUM (DISTURBED)	Field screen readings sample reading (field blank reading)
			<u>14-16' CLAY</u> gravish brown (5 YR 3/2) to dusky brown (5 YR 2/2), slightly sandy, moderately cemented, very stiff, low plastic, slightly moist	<u>00-16'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.0 (0.0)
10			<u>20-40' SAMPLE</u> Recovered 20/20' = 100%	<u>20-40'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.0 (0.0)
			<u>CLAY</u> pale brown (5 YR 5/2) to light brown (5 YR 5/6), slightly sandy to very sandy (30-25 Ø), slightly calcareous streaked, moderately cemented, low plas- tic, moist	<u>00-80'</u> Composite sample BH63870008
15			<u>40-60' SAMPLE</u> Recovered 20/20' = 100%	<u>40-60'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.0 (0.0)
			<u>CLAY</u> light brown (5 YR 5/6), low plas- tic, slightly sandy to sandy, fine-grained, weakly cemented, moist	<u>60-80'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.0 (0.0)
20			<u>60-80' SAMPLE</u> Recovered 20/20' = 100%	
			<u>CLAY</u> light brown (5 YR 5/6) to vary- ing gravish brown, sandy (30-25 Ø) and fine-grained with scattered coarse sands, weakly cemented, low plastic, moist to very moist at bottom	

LOG OF BOREHOLE

Location _____
 Coordinates _____
 Total Depth _____
 Drilling Company _____
 Date Drilled _____
 Drilling Method _____
 Logged By _____
 Geologist

Borehole/Well No 52-67/BH63-67
 Ground Surface Elevation _____
 Water Level Encountered _____
 Static _____
 Driller _____
 Helper _____
 Drilling Fluid _____
 Checked By _____
 Site Manager
 CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20			<u>8.0-10.0' SAMPLE</u> Recovered 20/20' = 100% CLAY moderate yellowish brown (10 YR 5/4) to pale brown (5 YR 5/2), fine-grained sand (3.0-3.5 Ø up to 2.5-2.0 Ø), few scattered subangular and subrounded gravels 0.5 mm up to 2.5 mm, medium plastic, moderately cemented, moderately oxide (Fe) stained, moist	<u>8.0-10.0'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.0 (0.0)
25			<u>10.0-12.0' SAMPLE</u> Recovered 20/20' = 100% CLAY moderate yellowish brown (10 YR 5/4) to pale brown (5 YR 5/2), slightly sandy to sandy with small size scattered gravels, moderately to weakly cemented, moist	<u>10.0-12.0'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.0 (0.0)
30			<u>12.0-14.0' SAMPLE</u> Recovered 17/20' = 85% 12.0-12.2' CLAY same as above 12.2-13.7' CLAYEY SAND AND GRAVEL moderate brown (5 Y 4/4) to moderate yellowish brown (10 YR 5/4), fine-grained sand, well sorted, ranging from 3.0-2.5 Ø up to 0.5-1.0 Ø, gravel range 0.25 mm up to 3.75 mm, subangular with some subrounded, weakly cemented very moist to moist	<u>12.0-13.7'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.6 (0.0) <u>12.0-13.7'</u> Sample taken BH638712DH
			<u>14.0-16.0' SAMPLE</u> Recovered 15/20' = 75% CLAYEY SAND AND GRAVEL moderate reddish brown (10 R 4/6) to a dark reddish brown (10 R 3/4), well graded sand and gravel ranging from 0.5 mm up to 2.75 mm, weakly cemented, moist to wet streak at 15.2-15.5'	<u>14.0-15.5'</u> Field screen reading HNu = 1.80 (2.10), OVA = 0.0 (0.0) <u>16.0-17.8'</u> Field screen reading HNu = 0.0 (0.0), OVA = 0.0 (0.0)

LOG OF BOREHOLE

Location _____
Coordinates _____
Total Depth _____

Drilling Company _____
Date Drilled _____
Drilling Method _____
Logged By _____
Geologist

Borehole/Well No 72-87/BH63-87
Ground Surface Elevation _____
Water Level Encountered _____
Static _____

Driller _____
Helper _____
Drilling Fluid _____
Checked By _____
Site Manager
CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<u>16.0-18.0' SAMPLE</u> Recovered 1 8/20' = 90% CLAYEY SAND AND GRAVEL same as above, moist	
			<u>18.0-20.0' SAMPLE</u> Recovered 0 4/20' = 20% SAND AND GRAVEL same as above	
			<u>ARAPAHOE FORMATION</u>	<u>18.0-18.4'</u> Upper contact sample BH638718UC
			<u>20.0-22.0' SAMPLE</u> No recovery CUTTINGS weathered claystone	HNu background=0 4 OVA background=3 4 No Ludlum readings above background along core sample recovered
			<u>22.0-23.0' SAMPLE</u> Recovered 0 5/10' = 50% WEATHERED CLAYSTONE disturbed sample recovery	<u>22.0-22.5'</u> Contact sample taken BH638722CT
			<u>23.0-24.0' SAMPLE</u> No recovery	<u>24.5-26.0'</u> Bedrock sample BH638724BR
			<u>24.0-24.5' SAMPLE</u> No recovery Drilled with center bit	<u>26.0-28.0'</u> Field screen readings HNu = 00 (00), OVA = 00 (00)
			<u>24.5-26.0' SAMPLE</u> Recovered 1 5/15' = 100% WEATHERED CLAYSTONE medium dark gray (N 4/0), massive, blocky, medium to highly plastic, moist	

LOG
OF
BOREHOLE

Location _____

Coordinates _____

Total Depth _____

Drilling Company _____

Date Drilled _____

Drilling Method _____

Logged By _____

Geologist

Borehole/Well No 52-87/BH63-87

Ground Surface Elevation _____

Water Level Encountered _____

Static _____

Driller _____

Hoiberg _____

Drilling Fluid _____

Checked By _____

Site Manager

CEARP Manager

Comments _____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
			<p><u>26.0-28.0' SAMPLE</u></p> <p>Recovered 20/20' = 100%</p> <p>WEATHERED CLAYSTONE medium dark gray (N 4/0) to medium light gray (N 6/0), slightly oxide stained, massive, blocky, moist</p> <p>TOTAL DEPTH 28.00'</p>	

WELL COMPLETION INFORMATION

Location Rocky Flats Plant, 881 Hillside Area

Well No 52-87/BH63-87

Coordinates N 35161 94 E 20954.54

Elevation Ground Surface 5967.57'

Total Depth Well 20.50'

Top of Casing 5969.57'

Borehole 28.00'

Formation of Completion Colluvium

Casing Material Sch 5, Type 316 TFJ stainless steel

Casing Diameter 2" ID

Screen Material 0.010" wire wrap 316 TFJ stainless steel

Surface Casing Diameter 5" ID

Date Installed October 20, 1987

Approved By _____

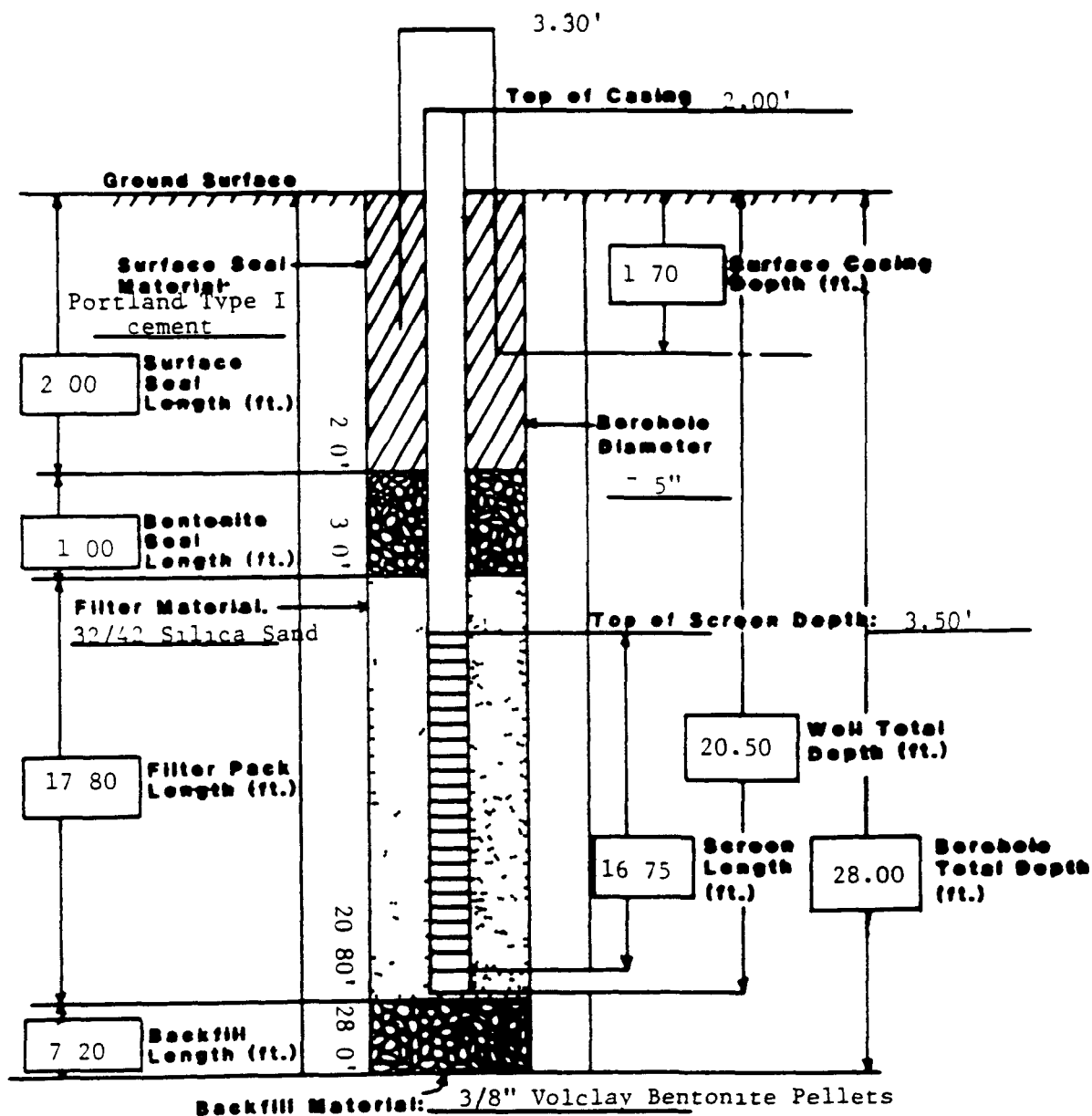
Installed By R T Treat

Site Manager _____

Geologist

Project Director _____

Comments _____



APPENDIX 5

CEARP PHASE 2: INSTALLATION GENERIC
MONITORING PLAN (IGMP); SAMPLING PLAN

**DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATIONS OFFICE
ENVIRONMENT, SAFETY AND HEALTH DIVISION
ENVIRONMENTAL PROGRAMS BRANCH**

**COMPREHENSIVE ENVIRONMENTAL ASSESSMENT
AND RESPONSE PROGRAM**

**PHASE 2:
ROCKY FLATS PLANT
INSTALLATION GENERIC MONITORING PLAN
(Comprehensive Source and Plume Characterization Plan)**

SAMPLING PLAN

February 1987

DRAFT

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1. INTRODUCTION

CEARP Phase 2 Confirmation consists of CEARP Phase 2a, Monitoring Plan, and CEARP Phase 2b, Site Characterization (Remedial Investigation) This Sampling Plan is one component of the Monitoring Plan for Rocky Flats Plant The Monitoring Plan typically consists of five parts Synopsis, Sampling Plan, Technical Data Management Plan, Health and Safety Plan, and Quality Assurance/Quality Control (QA/QC) Plan Because of the Compliance Agreement between the State of Colorado, the Environmental Protection Agency, and the Department of Energy (DOE), this Monitoring Plan also includes a Feasibility Study Plan

CEARP uses a three-tiered approach in the preparation of monitoring plans the CEARP Generic Monitoring Plan (CGMP), the Installation Generic Monitoring Plan (IGMP), and the Site Specific Monitoring Plans (SSMPs) This revised IGMP serves as the Comprehensive Source and Plume Characterization Plan required by the Compliance Agreement Therefore, the acronym used to refer to this plan is IGMP/CSPCP

This IGMP/CSPCP Sampling Plan details specific guidance for implementation of CEARP Phase 2b site characterizations (remedial investigations) at Rocky Flats Plant and follows the guidance provided in the CGMP The Sampling Plan is complemented by and inseparable from the Technical Data Management Plan and the Quality Assurance/Quality Control (QA/QC) Plan Sections of the Sampling Plan are supported by reference to the other plans, and to the Synopsis Emphasis is placed on integration of efforts for each of the CEARP Phases Phase 3 (Technological Assessment), Phase 4 (Remedial Action), and CEARP Phase 5 (Compliance and Verification)

This IGMP/CSPCP Sampling Plan provides the following basic components of sample/measurement collection and analysis at Rocky Flats Plant

- objectives and goals of the investigation,
- methods and procedures and their justification,
- transportation and shipping information, and
- guidance for the site-specific investigations

The initial CEARP Phase 2 site characterization (remedial investigation) has provided considerable data to define regional and installation-wide geology, hydrology, and water quality. These data will be further analyzed and interpreted as a first step of the site characterization (remedial investigation) being performed under this IGMP/CSPCP Monitoring Plan. This analysis will define additional installation-wide data needs to enhance understanding of the surface water and groundwater pathways. Some of these data needs have been identified, and are presented in Section 3 of this Sampling Plan. Additional installation-wide sampling locations, soils boring locations, and monitoring well locations may be identified based on the results of these analyses.

Current understanding of the hydrogeological system and contaminant sources at Rocky Flats Plant has resulted in definition of several high-priority sites (DOE 1986f). These sites appear to be the primary sources of the known groundwater plumes. Therefore, the installation-wide source and plume characterization (remedial investigation) will be accomplished by first evaluating these high-priority sites, tracing the contaminant plumes originating from these sites, and integrating these data on an installation-wide basis. Second, all lower-priority sites will also be characterized and these data incorporated into the data base. The details of the site-specific plume characterizations will be presented in the SSMPs. The installation-wide characterization (remedial investigation) presented in this IGMP/CSPCP may be modified based upon the results of these site-specific analyses.

The premise of this Sampling Plan is that installation-wide data needs are mostly satisfied by site-specific requirements. Installation-wide needs encompass additional clarification of the sources contributing to and contaminant levels within the groundwater plumes, definition of interconnections and contaminant transport within the hydrogeologic system, and identification of gaps within the data base. To address these needs, this Sampling Plan was organized as follows:

- The remainder of the introduction outlines the objectives of the site characterization
- Section 2 presents the site survey and mapping criteria that ensure a common frame of reference
- Section 3 identifies installation-wide and site-specific data requirements

- Section 4 presents the sampling plan and rationale to be followed
- Section 5 identifies the sample numbering system
- Section 6 identifies sampling equipment and procedures
- Section 7 discusses sample analysis and handling
- Section 8 presents sample documentation and tracking procedures

1 1 INTEGRATED APPROACH

Sampling at Rocky Flats Plant will be conducted using an integrated approach. The integrated approach is summarized in the Synopsis (Section 5.2) and detailed here. The integrated approach breaks site characterization (remedial investigation) activities into stages, in which the results from previous stages of sampling are used to refine the conceptual model used to design successive stages of sampling. This iterative process incorporates the experience and knowledge gained from each stage to minimize the total number of samples required to adequately characterize the site and to provide the necessary data base to prepare feasibility studies for alternative remedial actions. The benefit of staged sampling is greater flexibility within the sampling program with a minimum of cost.

1 2 OBJECTIVES OF THE SAMPLING PROGRAM

The overall objectives of CEARP Phase 2b site characterizations (remedial investigations) are to

- verify and characterize contaminant sources,
- determine the present areal and vertical extent of groundwater contamination plumes,
- estimate potential for contaminant migration (including rate and direction) to support risk assessment studies,
- support identification and technology assessments (feasibility studies) of alternative response actions, including the alternative of "no action," and
- support of long term monitoring and verification

These objectives are detailed for particular elements of the sampling program, as follows

1 2.1 Location of Waste Sites

The locations and boundaries of waste sites will be defined under CEARP Phase 2b site characterizations (remedial investigations) in order to delineate source areas for potential cleanup (e.g., removal or containment). This will enable evaluation of the potential for migration of contaminants into the environment and evaluation of alternative remedial actions.

1 2.2. Soils and Geology

Sampling of geologic materials at Rocky Flats Plant will include sampling of soils and waste materials found within the soils and bedrock. The objective of this sampling is to confirm the types, concentrations, and extent of wastes and/or contaminant migration.

Geotechnical characterization at Rocky Flats Plant will be performed to support the evaluation of waste migration (e.g., sampling and testing for hydraulic properties) and to support the technological assessments (feasibility studies) of alternative remedial actions.

1 2.3 Groundwater

The CEARP Phase 1 Assessment of Rocky Flats Plant recommended hydrogeochemical investigations of the aquifer systems in the immediate vicinity of the plant based on the ongoing hydrogeological studies. An initial CEARP Phase 2b site characterization (remedial investigation) was conducted in 1986 with the objective of supplementing the existing hydrogeochemical understanding of the location, direction, rate of movement, recharge, and discharge of the hydrogeologic systems. Under the revised IGMP/CSPCP, this investigation will be expanded to fill area-wide and site-specific hydrogeologic data gaps. Ultimately, the investigation has the objective of providing a comprehensive data base for evaluating remedial actions.

Existing groundwater quality data indicate that radioactive and chemical contaminants have entered the groundwater flow system. As a result of this information, radioactive and chemical contamination in groundwater will be a major focus of the site characterization (remedial investigation) activities. The objectives of groundwater sampling are as follows:

- Identify and characterize the source(s) of contaminants in the groundwater
- Determine the present areal and vertical extent of groundwater contamination
- Estimate the potential for contaminant migration (including rate and direction) to support risk assessment studies
- Support the identification and technology assessments (feasibility studies) of alternative remedial actions

1.2.4 Surface Water

Surface water was not identified as an important pathway for contaminant migration in the CEARP Phase I Installation Assessment. All available surface water data are presented in the Geological and Hydrological Data Summary for Rocky Flats Plant (RI 1986c). The additional 42 surface water sampling locations used in the initial CEARP Phase 2 site characterization were selected based on these data and perceived data gaps. Approximately half of these 42 stations were dry during the 1986 sampling season. These stations will be sampled as part of the site characterization (remedial investigation) being conducted under this IGMP/CSPCP Monitoring Plan. The primary objective of surface water sampling under this IGMP/CSPCP Sampling Plan is to support the characterization of the hydrogeochemical setting at Rocky Flats Plant by providing data on the interconnection between surface water and groundwater.

1.2.5 Biota

The CEARP Phase I Assessment for Rocky Flats Plant and the Radioecology and Airborne Pathway Summary Report (RI 1986b) did not identify biota as a significant pathway for contamination. There are no current plans for biological sampling.

1 2.6. Air

The CEARP Phase I Assessment of Rocky Flats Plant and the Radioecology and Airborne Pathway Summary Report (RI 1986b) did not identify air as a significant pathway for contamination. Existing air monitoring programs appear to have adequately characterized the air pathway, and there are no current plans for additional air pathway characterization. However, air will be monitored under the health and safety program. If this monitoring indicates that sampling activities are impacting the air pathway, more characterization data will be collected as appropriate.

1 3. SCOPE

The sampling activities outlined in this Sampling Plan will be completed in two or more stages in line with the integrated approach being used by CEARP. The scope of sampling and subsequent stages of sampling will be refined based on data analyses. The anticipated scope of sampling corresponds to the data needs described in the Synopsis. SSMP Sampling Plans will be prepared for each site or group of sites, as appropriate.

Data collection activities that apply generically to all or most sites include the following:

- geophysical and soil gas surveys to locate waste sites and describe metallic objects within wastes,
- land surveying to tie in geophysical surveys and provide precise locations of sites, and to provide a baseline for the location of sampling at sites, and
- aerial photography to identify waste sites and past waste disposal practices.

1 3.1. Soils and Geology

Sampling of geologic materials and wastes will be conducted during the CEARP Phase 2b site characterizations (remedial investigations). Sampling may include both soil and soil gas sampling. The scope of anticipated sampling includes the following:

- sampling of soil gases using a field gas chromatograph, photoionization detector and/or organic vapor analyzer,
- sampling and analysis of soil to determine the presence, concentration, and distribution of potential contaminants, and
- sampling, analysis, and testing of soil in support of hydrogeochemical characterizations and engineering studies

1.3.2 Groundwater

Groundwater samples will be taken to refine the site-wide hydrogeological conceptual model and to determine the extent of contaminant migration within groundwater of the plant

The scope of groundwater characterization includes investigation of the quality of water within both the alluvium and bedrock. This includes borings and monitoring well installation in areas adjacent to waste sites. Surface geophysical methods and soil gas investigations are within the scope of this characterization.

1.3.3 Surface Water

The scope of surface water characterization at Rocky Flats Plant includes sampling of streams, ditches, and seeps which might be impacted by contaminants.

1.4 SCHEDULE

CEARP Phase 2b sampling activities at Rocky Flats Plant will begin at high-priority sites under the Site-Specific Monitoring Plan. The sampling schedule is presented separately.

2. SITE SURVEY AND MAPPING

Surveying and mapping will be conducted at an installation level to assure a common frame of reference for all site characterizations (remedial investigations). All monitoring stations will be surveyed unless a high degree of accuracy is determined unnecessary for a particular station. Additional detail and guidance regarding site surveys and mapping is provided in the Technical Data Management Plan.

2.1 INSTALLATION COORDINATE SYSTEM

All monitoring locations will be described in accordance with the Rocky Flats Plant Installation Coordinate System. The plant coordinate system has been tied into the Colorado State Coordinate System using benchmarks established by the USGS. Horizontal survey data will be reported in both Rocky Flats coordinates and State coordinates so data collected on plant site can be related to regional data as necessary. Elevations will be reported in English units as feet above mean sea level.

2.2 AREA OF INTEREST

The area of interest to be surveyed and mapped has been established according to the guidelines contained in the Technical Data Management Plan. Rocky Flats Plant is contained within one property boundary. Thus, the area of interest extends to the plant property boundaries.

2.3 SCOPE OF WORK FOR SURVEYING

Tolerances of ± 0.01 ft vertically and ± 0.1 ft horizontally will be used in locating base stations and control points. Tolerances of ± 0.01 ft vertically and 1 ft horizontally will be allowed when surveying sampling locations.

3 DATA REQUIREMENTS

This section presents an overview of the present situation and data requirements for installation-wide source and plume characterization at Rocky Flats Plant in accordance with the Compliance Agreement. Also included are general requirements for CEARP Phase 2b site characterizations (remedial investigations). Detailed data collection requirements for specific sites will be presented in the appropriate SSMP Sampling Plans. The goal of CEARP Phase 2b efforts is to collect sufficient data to meet the requirements of site characterizations, feasibility studies and risk/endangerment assessments, to identify alternatives for remedial action and to plan long term monitoring and verification.

3.1 INSTALLATION DATA NEEDS

Installation-wide data needs have been identified as necessary to support the characterization of contaminant plumes, and to develop and continually refine conceptual models of contaminant transport. The data required for installation-wide site characterization (remedial investigation) may be broken into four major categories: sources, geology, groundwater, and surface water.

This section presents a brief summary of the current environmental situation at the Rocky Flats Plant and identifies gaps in the existing data base. Section 4 presents the Sampling Plan to fulfill identified data needs.

3.1.1 Solid Waste Management Units

Solid Waste Management Units (SWMUs) were identified in the RCRA Part B Permit Application (DOE 1986b). Each of these solid waste management units was assigned a reference number and located on an aerial photograph base map (Plate 1). This base map and a tabulation of all solid waste management units cross-referenced to the CEARP Phase I report is presented in the Rocky Flats Plant IGMP/CSPCP Synopsis.

The locations and nature of solid waste management units at Rocky Flats Plant have been defined based on existing information (DOE 1986b, DOE 1986f). Further

investigations of these solid waste management units should include precisely locating each unit and sampling in or near the unit to verify reported locations and contents

3.1.2. Soils and Geology

3.1.2.1 Geology

Available geologic data at Rocky Flats Plant consists of numerous regional and installation-specific geologic and geotechnical reports. Stratigraphy and lithology are available from geotechnical investigations at the present landfill, the solar ponds, various onsite buildings, and from groundwater monitor well installations. These data are presented in the Geological and Hydrological Data Summary for Rocky Flats Plant (RI 1986c). In addition, detailed mapping of surficial and bedrock geology at the plant was performed as part of the initial CEARP Phase 2b site characterization (remedial investigation) performed in 1986 in response to the Compliance Agreement.

Surficial Geology Surficial deposits at Rocky Flats Plant consist of Rocky Flats Alluvium, several alluvial materials in the valleys, and colluvium. The valley alluvial materials are Verdos Alluvium, Slocum Alluvium, recent terrace alluviums and recent channel deposits (valley fill). The general composition and lateral extent of surficial deposits were well defined by the 1986 mapping effort (DOE 1986f). The thickness and compositional variations of alluvium and colluvium were well defined where borehole data exist (DOE 1986f).

Additional installation-wide data on surficial geology are not considered necessary. However, additional site-specific surficial geology data will be collected during monitor well installation as presented in the SSMP Sampling Plans.

Bedrock Bedrock units beneath Rocky Flats Plant consist of Cretaceous Fox Hills Sandstone, Laramie Formation and Arapahoe Formation. The Fox Hills Sandstone and lower Laramie Formation sandstones outcrop in clay pits west of the plant and were characterized by the 1986 geologic mapping (DOE 1986f). The upper Laramie Formation claystones subcrop beneath the Rocky Flats Alluvium in the western plant buffer zone, and the Arapahoe Formation subcrops immediately beneath and east of the plant. Outcrops of these formations were located by the 1986 geologic mapping, however, the contact between the Laramie and Arapahoe Formations could

not be positively identified in the field (DOE 1986f) Based on boring logs, the contact was estimated to be below the the first Arapahoe sandstone that was greater than 5 ft thick (DOE 1986f)

Because the Arapahoe Formation subcrops beneath and east (downgradient) of the plant, the locations and extent of sandstone bodies within the formation are important to an understanding of the bedrock flow system and contaminant transport During the initial CEARP Phase 2b site characterization (remedial investigation), bedrock wells were cored to the first total sandstone cumulative thickness of 3 ft within a 10-ft interval, and bedrock monitor wells were completed in these sandstones This drilling program identified numerous sandstone bodies at various depths beneath the plant which were previously unidentified The sandstones are lenticular, discontinuous and stratigraphically complex (DOE 1986f)

An installation-wide bedrock investigation may be necessary to support the quantification of groundwater flow patterns and solute transport in the groundwater If warranted, based on plume characterizations, additional core data will be collected to determine the extent of known sandstones and to locate previously unidentified sandstone lenses

3 1.2.2. Geotechnical

Geotechnical tests have been conducted on materials from many of the onsite borings Data collected to date include standard penetration tests, Atterburg limits, and grain-size analyses of various materials (RI 1986c) Cores have been collected during the initial CEARP Phase 2b site characterization (remedial investigation) that will be tested to evaluate permeabilities, porosities, and physical properties of bedrock and alluvial units in support of hydrogeologic characterization Based on the results of these tests, additional installation-wide data needs may be identified

3 1.3 Groundwater

3 1.3 1 Hydrology

There are two hydraulically-connected groundwater flow systems at Rocky Flats Plant These occur in the Rocky Flats Alluvium and other surficial materials,

and in the bedrock (primarily in the claystones and sandstones of the Arapahoe Formation)

Presented below is a discussion of each flow system and the data needs to support potential groundwater modeling efforts

Shallow Flow System The shallow alluvial groundwater system in the Rocky Flats Alluvium and other surficial materials occurs under unconfined conditions. The system is recharged by infiltration of incident precipitation and surface water. Shallow groundwater flow generally follows topography to the east and toward the drainages. Discharge areas are springs and seeps at the alluvium/bedrock contact and major drainages. The shallow system appears to be quite dynamic, as large water table fluctuations occur in response to seasonal stresses. As a result of these fluctuations, large unsaturated zones within the system occur during certain portions of the year.

Shallow groundwater flow rates were calculated based on single-hole draw-down-recovery test data collected during the initial CEARP Phase 2b site characterization (remedial investigation) (DOE 1986f). Data available to date indicate mean hydraulic conductivities as follows:

<u>Material</u>	<u>Hydraulic Conductivity (cm/sec)</u>
Rocky Flats Alluvium	7×10^{-5}
Walnut Creek Alluvium	3×10^{-5}
Woman Creek Alluvium	3×10^{-3}

The effective porosity of alluvial materials is assumed to be 0.1 (Hurr 1976). Based on the hydraulic conductivities presented above, an assumed effective porosity of 0.1, and gradients determined from the initial CEARP Phase 2 site characterization, groundwater velocities were calculated for each geologic unit listed above. The horizontal velocity is approximately 14 ft per year in the Rocky Flats Alluvium, approximately 900 ft per year in Woman Creek alluvium and approximately 9 ft per year in Walnut Creek alluvium. Dissolved chemical species do not migrate as far as implied by the velocity calculations because the surficial materials are not saturated year-round. Portions of the Rocky Flats Alluvium are probably saturated throughout the year, and conservative (nonattenuated) species in Rocky Flats Alluvium ground-

water could travel annual distances of the order calculated. However, conservative species in valley fill groundwater cannot travel the predicted distances because these materials are dry during portions of the year (1986f).

The shallow flow system at Rocky Flats Plant is generally understood, however, additional flow data are needed for a detailed understanding of the system. Seasonal water level fluctuations and unsaturated zones within the system need to be better defined on an installation-wide scale to describe the dynamic groundwater flow system. Hydraulic conductivity and effective porosity values also need to be determined in the field for the Woman Creek Alluvium to support a quantitative evaluation of solute transport at Rocky Flats Plant.

Bedrock Flow System Most groundwater flow in the Arapahoe Formation occurs in lenticular sandstone bodies contained within the claystones. Recharge to the sandstones occurs by leakage through the claystones or where the sandstones are in direct contact with saturated surficial materials. Groundwater in the sandstones flows east toward the point of regional discharge along the South Platte River.

Groundwater flow rates estimated by DOE (1986f) were based on the initial CEARP Phase 2 site characterization (remedial investigation) and regional data. Based on single-hole drawdown-recovery tests and packer tests, the sandstones have an average hydraulic conductivity of 2×10^{-6} cm/sec. Average hydraulic conductivity values for weathered and unweathered claystone were developed using packer test data. These values were approximately 5×10^{-7} cm/sec for weathered claystone and 1×10^{-7} cm/sec for unweathered claystone. Assuming an effective porosity of 0.1 and the regional gradient, the horizontal velocity of the sandstones was estimated to be approximately 0.6 ft per year (DOE 1986f).

There is a strong downward gradient between the shallow and bedrock flow systems (DOE 1986f). These gradients range from 0.20 to 1.0 based on onsite water level data from paired bedrock and shallow wells. No vertical conductivity values are available for the claystones, however, a value one-third of the horizontal conductivity of 1×10^{-7} was assumed in order to calculate a downward groundwater velocity of 0.1 ft per year (DOE 1986f).

Additional data are needed to better define bedrock flow directions and velocities at Rocky Flats Plant. Refined horizontal and vertical hydraulic conductivity as well as effective porosity values are needed for the sandstones and claystones to further evaluate groundwater flow velocities and solute transport. Further testing of well pairs is also needed to investigate vertical gradients between the shallow and bedrock flow systems.

3.1.3.2 Quality

Groundwater conditions at Rocky Flats Plant have been monitored since 1961 and chemical data exist for monitoring over the past ten years. In addition, groundwater samples were collected from 27 existing wells and the 69 new wells during the initial CEARP Phase 2 site characterization (remedial investigation) (Plate 2). Based on these data, a one-time characterization of alluvial and bedrock water quality is presented in the RCRA Part B Permit Application (DOE 1986f) and summarized in the IGMP/CSPCP Synopsis. This characterization includes a discussion of background and downgradient water quality. Because the groundwater quality discussion presented by DOE (1986f) is based on a one-time sampling event, seasonal water quality fluctuations need to be evaluated on an installation-wide basis. Quarterly groundwater quality data are being collected as specified in the RCRA Part B Operating Permit Application. In addition, site-specific groundwater quality will be evaluated during CEARP Phase 2b site characterizations.

3.1.4 Surface Water

3.1.4.1. Hydrology

Three intermittent streams drain Rocky Flats Plant. Flow is generally from west to east. Rock Creek drains the northwestern corner of the plant site and flows to the northeast toward its offsite confluence with Coal Creek. Woman Creek drains the southern portion of the plant site and flows eastward to Standley Lake. North and South Walnut Creek and an unnamed tributary drain the remainder of the plant site. A series of dams, retention ponds, diversion structures and ditches have been constructed at the plant to control surface water and limit the potential for release of

poor quality water. A detailed discussion of this system is presented in the RCRA Part B Permit Application (DOE 1986f).

The surface water flow system is well understood and documented (DOE 1986f). Surface water flow needs to be monitored on an installation-wide scale to describe seasonal fluctuations in flows and to support groundwater flow and solute transport modeling.

3.1.4.2. Quality

Surface water quality is characterized in detail in the RCRA Part B Permit Application (DOE 1986b). This characterization is based on a one-time site characterization sampling event and NPDES monitoring. The initial CEARP Phase 2 site characterization (remedial investigation) characterized surface water hydrology by measuring flow rates and sampling surface water at onsite sampling stations (Plate 2).

Surface water discharged from retention ponds is monitored regularly to document compliance with NPDES permit requirements. The NPDES permit is issued and regulated by EPA and requires the plant to monitor for specific pollutants at seven discharge locations. These seven discharge locations are pond B-3 (discharge 001), pond A-3 (discharge 002), Reverse Osmosis Pilot Plant (discharge 003), Reverse Osmosis Plant (discharge 004), pond A-4 (discharge 005), pond B-5 (discharge 006) and pond C-2 (discharge 007). Sanitary effluent limitations are placed on pond B-3 (sewage effluent), and limitations for nitrate and pH are placed on pond A-3. Discharge limits apply to the Reverse Osmosis Plant, and limitations on sediment release apply to ponds A-4, B-5 and C-2. In addition to NPDES permit requirements, all of these discharges are monitored for pH, nitrate as nitrogen, nonvolatile suspended solids, plutonium, americium, uranium, and tritium (RI 1986a).

Surface water quality was characterized by DOE (1986f). However, continued monitoring of NPDES discharge locations and the other surface water sampling locations is necessary to define seasonal fluctuations in surface water quality.

3 2 SITE-SPECIFIC DATA NEEDS

Data needs at the solid waste management units may be separated into three major categories soils and geology, groundwater, and surface water

3 2.1 Soils and Geology

3 2.1 1 Soils and Wastes

Data needs for soils include geotechnical data (e g, grain size, clay content, moisture content, compaction, and permeability), vadose zone data (e g, adsorptive capacity, buffering capacity, and pore fluids and soil chemistry), and variability of these parameters Collection of soil data may be accomplished by detailed soil sampling and testing and/or installation of soil water samplers as necessary In addition, the extent of surficial contamination may be investigated by collecting surface soils and screening them for radioactive materials

Data needs for waste characterization will include sources, site boundaries, physical state, composition, and concentrations of waste materials

3 2.1 2. Geology

Geologic data needs include depth and composition of surficial materials, the local extent and lithology of existing sandstones, and the geotechnical characteristics of both surficial and bedrock materials

3 2 2 Groundwater

Groundwater data needs include the monitoring of water levels, the determination of water quality and hydraulic conductivity, definition of local stratigraphy and lithology, and quantification of seeps to surface Tasks designed to fill groundwater data needs at the high-priority sites will include installation of monitoring wells in both alluvium and bedrock, sampling and geotechnical testing of alluvial and bedrock materials, and sampling and analysis of groundwater The elevation of groundwater

will be measured in wells and at seeps to provide data for determination of ground-water flow directions. A complete description of the tasks to be implemented will be presented in the individual SSMP Sampling Plans.

3 2.3. Surface Water

Surface water data needs include topographic mapping, interceptor ditch flow, surface water flow and quality, and their variability. The surface water investigation will include preparation of detailed topographic maps of each area of investigation to determine drainage area characteristics. Water samples from the interceptor ditches and creeks will be collected from multiple locations upstream, adjacent to, and downstream from the area being investigated. Stream flow data may be collected from existing gauging stations or new installations.

4 SAMPLING PLAN AND RATIONALE

4.1 INSTALLATION-WIDE SAMPLING PLAN

The first task of this Sampling Plan will be to review all available data so that a conceptual understanding (model) of the existing system can be developed. The second task will be to identify specific locations where sampling and testing are to be conducted to test the conceptual model. Discussion of the probable techniques to be used for collecting data is provided below.

4.1.1 Soils and Geology

4.1.1.1. Soils and Wastes

Characterization of suspected waste sites will be conducted on a site-specific basis (Section 4.2). Characterization will include source locations, waste compositions, and evaluation of potential migration pathways. As stated in the introduction, most of the installation-wide characterization (remedial investigation) needs will be satisfied by activities carried out under site-specific investigations. These site-specific data will be used as input to the mathematical model(s) that will be used to evaluate contaminant transport through the various pathways on an installation-wide basis. Additional data needs identified by this modeling effort will then be identified.

4.1.1.2 Geology

Additional investigations of the geology at Rocky Flats Plant are anticipated to be confined to collection of site-specific data. Data to be generated include the thickness and composition of alluvial deposits, the local extent and lithology of sandstone units, and geotechnical parameters of both bedrock and alluvial deposits.

4.1.2 Groundwater

Characterization of groundwater flow and quality has been identified as an installation-wide data need. Characterization of contaminant plumes in either alluvial or bedrock units will be initiated on a site-specific basis.

Techniques to be used in developing these data may include multiple well-pumping tests, slug tests, and tracer tests. Monthly groundwater elevation measurements of all wells will be conducted for at least one year in order to determine seasonal variation in the potentiometric surface. Drilling and installation of additional groundwater monitoring wells in locations where data are lacking may be necessary.

The extent of groundwater quality data needs will be more accurately evaluated following reviews of the available data and the newly acquired site-specific data. All new and existing monitoring wells will be monitored quarterly to adequately characterize seasonal and spatial variation in groundwater quality.

4.1.3 Surface Water and Sediment

Characterization of surface water flow and surface water quality will be investigated on an installation-wide basis. Quarterly sampling of surface water in each drainage will be necessary to detect seasonal variation in surface water quality. Discharge information may be collected and evaluated from multiple locations on each drainage to further characterize surface water flow patterns and to evaluate the relationship between surface water and groundwater.

Sediment quality was characterized during the initial CEARP Phase 2 site characterization (remedial investigation) (DOE 1986f). On an installation-wide basis, additional sediment samples are not deemed necessary.

4.2 GUIDANCE FOR THE SITE-SPECIFIC SAMPLING PLANS

This section provides a brief overview of the planned environmental monitoring and site-specific characterization activities at Rocky Flats Plant. Detailed discussions of the site-specific sampling efforts and rationale will be included in the SSMP Sampling Plans.

4.2.1. Soils and Geology

4 2 1 1 Soils and Wastes

The delineation of waste site boundaries is an identified data need (Section 2 of the Synopsis) Geophysical surveys will be conducted to delimit the boundaries and identify some characteristics of waste sites The surveys will be tied in to the Installation Coordinate System and established benchmarks The surveys will include a sampling network specific to each potential waste site identified in the SSMPs, with systematic sampling on a grid basis

Specific geophysical techniques to be applied at Rocky Flats Plant are expected to include electromagnetic induction (EM), magnetometry, metal detection, and vertical electrical resistivity Electromagnetic induction and visual inspection will be used as the primary means of locating areas of disturbed soil It will also be used for reconnaissance of chemical spills Magnetometry and metal detection will be used to locate buried metallic objects The location of metallic objects will provide data on past burial operations and will be used as a guide for drilling locations to avoid drilling into those objects Resistivity will be used, as appropriate, to develop data on the vertical extent of the source areas

Sampling of soil and wastes will be conducted to confirm the extent and characteristics of potential contaminants and contaminant migration After waste site boundaries are delineated by the geophysical survey, the waste sites will be sampled using both soil gas sampling and soil borings

The specific number, location, depth, sampling interval, and requisite analyses for both direct and indirect samples will be specified in the SSMPs

4.2.1 2. Geology

Detailed investigation of the geology of each site to be characterized is needed in order to evaluate (1) the depth and composition of alluvial materials, (2) the local extent and lithology of sandstones, and (3) the geotechnical characteristics of both the alluvial and bedrock deposits

Borings and cores at selected locations through the alluvium and into bedrock will be used to generate geologic data. Samples of each unit will be collected and lithologically described to generate data on the composition and extent of geologic materials. Techniques for sample collection and description are included in Appendix A.

4.2.1.3 Geotechnical

Site-specific geotechnical data will include laboratory tests to evaluate permeabilities, effective porosities, and physical properties of bedrock and alluvial units. Installation needs will be identified as appropriate. Falling head permeability tests will be performed on bedrock cores to investigate horizontal and vertical laboratory permeabilities, and capillary moisture tests will be conducted on bedrock cores to estimate effective porosities. At least three samples of each bedrock unit will be tested to account for sample variability.

If existing data does not include physical properties data, physical properties tests will be performed on appropriate bedrock and alluvial materials. Physical properties tests will consist of grain-size analyses, Atterburg limits, and water content tests. Hydrometer tests will be performed if more than 50 percent of a sample passes the 200-mesh sieve. Physical property test results will be used to develop a basis for selecting monitor well screen and filter pack sizes, to compare visual field classifications on boring logs with laboratory results, and to calculate permeability values based on empirical correlations to physical properties.

4.2.2 Groundwater

Specific tasks to be completed in order to characterize the hydrogeology of Rocky Flats Plant are expected to include soil gas surveys, monitor well installation and sampling, and surface water sampling. Soil gas surveys will be completed in order to detect the distribution of volatile organic contaminants within the groundwater as well as to assist in locating source areas. Installation and sampling of groundwater monitoring wells will provide data on the flow and quality of groundwater in the vicinity of the sites.

4 2.3 Surface Water

Sampling of surface water will provide data on the potential impact of groundwater on surface water quality

4 2.4 Air

Monitoring of air for particulates and organic vapors will be maintained on a site-specific basis during invasive sampling (i.e., soil boring) for the purpose of protecting the health and safety of the sampling team. This monitoring will be used to determine the need, if any, for additional air quality sampling during site characterizations (remedial investigations). Specific air monitoring procedures to be used during invasive sampling will be specified in the SSMP Health and Safety Plans.

5 SAMPLE NUMBERING SYSTEM

Each sample collected for chemical analysis, including replicates, blanks, and quality control check samples, will be identified by a unique sample identification number. Samples are identified by installation (Rocky Flats Plant), location (i.e., well number), sample matrix, sample ID, date, and lot control number (for tracking lots associated with a particular blank, replicate, or quality control check sample). Sample results will be reported by matrix on the same basis.

Location ID and sample ID, including all of the above information, will be assigned by the subcontractor site manager. These data identifiers will be assigned prior to field activities. Field personnel will carry a list of designations, keyed to a map, into the field with them.

Additional locations may be assigned while field teams are onsite, if warranted. If additional locations are assigned during field activities, they will be documented by the field team. It will be the responsibility of the field team leader to make sure a "Location Information" form is completed. A copy of the form is included in Appendix B of the Technical Data Management Plan.

6 SAMPLING EQUIPMENT AND PROCEDURES

This section presents general procedures to be followed during the site characterizations (remedial investigations) at Rocky Flats Plant. Equipment and procedures to be used are presented in Appendix A.

6.1 SURFACE SOIL SAMPLES

Samples of surficial soil material may be collected from onsite areas of Rocky Flats Plant using a spade or scoop. The samples will be placed into the appropriate sample container, labeled, and transported to the laboratory, where they will be screened for radioactive contamination. The sampler will be decontaminated prior to each use in accordance with the standard protocol presented in Appendix A.

6.2 SOIL SAMPLES COLLECTED DURING DRILLING

Soil borings will be performed to characterize the nature and volume of wastes. General drilling and logging procedures are described in Appendix A. Site-specific modifications to these procedures will be included in individual SSMPs.

6.2.1 Samples for Laboratory Analysis

Continuous drive samples will be collected from the ground surface to total depth where possible. Total depth will vary depending on visual description of samples (i.e., presence of stains for metals) and qualitative screening for organics and radionuclides.

In general, up to six samples from each boring at suspected waste sources may be submitted for laboratory analysis. Screening will be used to determine which samples to submit for laboratory analysis. The purpose of screening is to obtain a preliminary indication of the magnitude and distribution of volatile contaminants, metals, and radionuclides in the subsurface. Selection of the samples will be based on the screening (visual, radiation, and organic vapors). Samples from the core at the following locations may be submitted to the laboratory:

- directly above the waste
- in the most contaminated zone of the waste
- directly below the waste
- at the base of the surficial material
- within the bedrock near the bedrock/alluvial contact

The exact location of the samples will be determined by interpretation of the visual characteristics, and radiation and organic vapor measurements. Two samples characterizing the most contaminated zone of the waste may be submitted should the zones of highest radiation and volatile organics not correlate. Also, a sample directly above the waste may not be submitted for analysis should this zone be at or near the surface, because the surface will adequately demark the upper bounds of the waste. Should the waste be located within the bedrock, only one coring below the waste will be submitted.

Soil samples will be collected from soil borings near waste sources to determine the extent and magnitude of soil contamination. Visual, radiation, and organic vapor screening will be used to determine which samples to submit for laboratory analysis. In general, up to three samples will be submitted for analysis.

Sampling equipment will be decontaminated prior to each use in accordance with the standard protocol presented in Appendix A.

6.3. MONITORING WELL INSTALLATION

Monitoring wells will be installed on a site-specific basis to characterize groundwater quality. Their locations will be based on geophysical and soil gas surveys.

General procedures for the installation of monitoring wells are described in Appendix A.

6.3.1. Installation of Soil Water Samplers

Soil water samplers (lysimeters) may be installed for characterization of the vadose zone. A procedure for the installation of soil water samplers is included in Appendix A.

6 3 2 Installation of Soil Water Monitors

Various devices to monitor soil suction or soil moisture content may be installed (e.g., tensiometers, neutron probe access tubes, thermocouple psychrometers, and resistance blocks). The specific devices will be detailed in the SSMP Sampling Plans. Procedures for installation of tensiometers are included in Appendix A.

6 4 GROUNDWATER SAMPLES

Migration through groundwater has been identified as a significant potential pathway for release of contaminants to the environment at Rocky Flats Plant. Sampling of groundwater is necessary to evaluate the degree of groundwater contamination which has occurred as well as the potential for future contaminant migration.

All wells will be purged before sampling. Procedures for well sampling and purging are presented in Appendix A.

6.5. HYDRAULIC TESTS

Groundwater systems may be tested to characterize hydraulic properties such as hydraulic conductivity and effective porosity, to calculate groundwater flow velocity, and to estimate other properties important to contaminant migration. Procedures for drawdown-recovery tests of monitoring wells are included in Appendix A.

6 6 SURFACE WATER SAMPLES

Surface water samples will be collected from streams, ditches, and seeps to assist in characterizing the hydrogeochemistry of Rocky Flats Plant. The samples will be collected according to the protocol presented in Appendix A.

6 7 STORAGE AND DISPOSAL OF DRILLING AND SAMPLING WASTES

Sampling and drilling activities could generate potentially hazardous solid and liquid "wastes". The activities, anticipated type and amount of waste, and planned handling of the wastes are summarized below.

- Waste boring sampling solid, auger cuttings and excess soil/cuttings collected but not retained in sample containers--returned to borehole upon completion (bentonite plugs placed at the base of the borehole to approximately 2 ft above the base of waste material and also at the surface of the borehole), liquid--none
- Surface soil sampling solid, any excess soil from that collected for the composite--returned to holes created by sample collection, liquid--none
- Sediment sampling solid, any excess sediment collected in auger but not retained in jars--left at sampling site, liquid--none
- Surface water sampling solid--none, liquid--none
- Monitoring well installation solid, bulked in drums for screening and/or composite testing and appropriate disposal when taken from suspect contaminated sites, otherwise left on land surface adjacent to well, liquid--none
- Vadose zone monitor installation solid, bulked in drums for composite testing and appropriate disposal when taken from suspect contaminated sites, otherwise, left on land surface adjacent to bore holes, liquid--none
- Pump testing liquid, discharged to plant waste treatment system when testing at a suspect contaminated site, otherwise, disposed of on ground surface
- Groundwater purging/sampling solid--none, liquid, purged from wells prior to sampling discharged to plant waste treatment system when testing at a suspect contaminated site, otherwise, disposed of on ground surface

Disposal of any bulked "wastes" will depend on analytical test results of samples taken to characterize the wastes. One composite sample will be taken on a site-by-site basis. Testing will be done for EP toxicity, hazardous characteristics, Hazardous Substance List (HSL) organics, and radioactive materials to determine acceptability at the Rocky Flats Plant waste treatment facilities. If the material cannot be accepted by the Rocky Flats Plant waste treatment and/or disposal facilities, it will be disposed of at an appropriate offsite facility. Solid wastes such as disposable booties, Tyvek, contaminated paper, and Saran Wrap, will be considered hazardous for disposal purposes, the subcontractor site manager will ensure that wastes are disposed of in an approved manner.

7 SAMPLE ANALYSIS AND HANDLING

The testing program for samples collected during implementation of this Sampling Plan will be summarized in individual SSMPs. All water sampled (i.e., surface water, effluents, soil water, and groundwater) will be tested in the field for pH, specific conductance, and temperature. The water, waste, and soil samples will be tested for select organic, inorganic, and radiological parameters using the analytical methods detailed in the IGMP/CSPCP Quality Assurance/Quality Control Plan.

7.1 SAMPLE CONTAINERS AND PRESERVATION

Sample containers and preservation are presented in Tables 7.1 and 7.2. Analytes will be identified on a site-specific basis in the SSMPs. Although initial sampling should not include collection of other than low-hazard environmental samples, guidance regarding high-, medium-, and low-hazard samples is provided.

7.1.1 High-Hazard Samples

High-hazard samples collected for chemical analysis, those collected from drums, tanks, or spills, where they have not been diluted by environmental conditions, will be contained and preserved in accordance with EPA protocols listed in Table 7.1. These samples will be shipped directly to the laboratory for preparation of extracts. The analysis to be performed must be specified at the time the high-hazard sample preparation is scheduled. All high-hazard samples will be placed in 8-oz wide-mouth glass jars, sealed in paint cans, and marked as hazardous. No preservatives are required for high-hazard samples.

Samples collected in locations where radioactive contamination could occur will be screened in the field. It is not anticipated that any samples will qualify as radioactive under DOT regulations.

7.1.2. Medium-Hazard Samples

Medium-hazard samples are those that have originated from drums or concentrated residues, but that have been diluted somewhat by environmental conditions. Medium-hazard samples will be contained, preserved and shipped as appropriate for

testing in accordance with EPA protocols listed in Table 7.2. All medium-hazard sample containers will be placed in paint cans and marked as hazardous. In all other respects, medium-hazard samples are treated in the same manner as low-hazard samples.

7.1.3 Low-Hazard Samples

Low-hazard samples are environmental samples in which contaminants have been significantly diluted by the environment. Low-hazard samples will be contained and preserved as appropriate for testing in accordance with EPA protocols listed in Table 7.2. If necessary, samples will be placed on ice immediately after collection to maintain a temperature of 4°C.

Most groundwater samples collected for soluble inorganic metals analysis will be filtered in the field or at an onsite laboratory as soon as possible after collection but prior to the addition of nitric acid preservative. Filtering will be done with a pressure filtration device and 0.45-micron filter. Surface water samples and groundwater samples collected for total metals analysis will not be filtered prior to acid preservation.

7.1.4 Radiological Samples

Radioactive contamination of soils and water is of concern at Rocky Flats Plant. Only low-level samples are anticipated, however, samples will be screened in the field to confirm that expectation. All soil samples to be analyzed for radionuclides (e.g., tritium, uranium, plutonium, americium, and strontium) will be collected, contained, and preserved according to protocols specified for metals and cyanide in soil and sediment (Table 7.2). All water samples to be analyzed for these parameters will be collected, contained, and preserved identically to low-concentration minerals in water (Table 7.2).

7.2 SAMPLE PACKAGING AND SHIPMENT

7.2.1 High-Hazard Samples

In preparation for shipment to the analytical laboratories, all high-hazard samples will be packaged in accordance with the following procedures

- Sample container caps will be tightened securely and sealed with tape, liquid levels will be marked if bottles are partially full
- Sample labels will be securely attached to the sample container, each sample container will be placed in a zip-loc baggie (TM), ensuring that labels can be read
- All bagged sample containers will be placed in paint cans, and the cans will be filled with vermiculite
- The paint cans will be placed in a cooler lined with two inches of vermiculite or equivalent absorbent packing material, each paint can will be surrounded by packing material and all remaining space in cooler will be filled with additional packing material
- Chain-of-custody forms will be placed in a manila envelope, the envelope will be placed in a zip-loc baggie (TM) and taped to the inside of the cooler lid
- The cooler will be closed and sealed shut with strapping tape, if the cooler has a drain port, it will be sealed shut with tape, custody seals will be placed across the closure at the front of the cooler
- The cooler will be marked with labels indicating hazardous substances
- If shipped offsite, the shipper's and consignee's addresses will be fixed to the top of the cooler, if the samples are liquid, "This End Up" labels will be placed appropriately
- The cooler will be shipped to a laboratory

High-hazard samples will be shipped within twenty-four hours of collection if sent to an offsite laboratory

7 2.2 Medium-Hazard Samples

Medium-hazard samples will be packaged in the same manner as high-hazard samples. Organics samples will be shipped within twenty-four hours of collection if sent to an offsite laboratory. Inorganics samples will be shipped within forty-eight hours if sent to an offsite laboratory.

7 2.3 Low-Hazard Samples

In preparation for shipment to the analytical laboratories, all low-hazard samples will be packaged in accordance with the following procedures:

- The sample will be checked for proper preservation, the sample container cap will be tightened securely and sealed with tape, liquid levels will be marked if bottles are partially full.
- Sample labels will be securely attached to the sample container, each sample container will be placed in a zip-loc baggie (TM), ensuring that labels can be read.
- The bagged sample containers will be placed in a cooler lined with two inches of vermiculite or equivalent absorbent packing material, each sample will be surrounded by packing material and all remaining space in the cooler will be filled with additional packing material.
- Chain-of-custody forms will be placed in a manila envelope, the envelope will be placed in a zip-loc baggie (TM) and taped to the inside of the cooler lid.
- The cooler will be closed and sealed shut with strapping tape, if the cooler has a drain port, it will be sealed shut with tape, custody seals will be placed across the closure at the front of the cooler.
- If shipped offsite, the shipper's and consignee's address will be affixed to the top of the cooler, if the samples are liquid, "This End Up" labels will be placed appropriately.

Samples for organic analyses will be shipped within twenty-four hours of collection if sent to an offsite laboratory. Samples for inorganic analyses will be shipped within forty-eight hours of collection if sent to an offsite laboratory.

7 2 4 Radiological Samples

Environmental samples for radiological analysis should be low-hazard and if shipped offsite will be shipped according to the procedures for low-hazard samples. Samples collected during soil sampling will be screened for radioactivity. Should radioactivity levels exceed DOT criteria for classification as radioactive (specific activity greater than 0.002 microcuries per gram), they will be labeled and shipped according to DOT regulations if sent offsite.

**Table 7.1 Required Sample Containers and Preservation
for High-Hazard Samples¹**

<u>Testing</u>	<u>Containers</u>	<u>Preservation</u>
<u>Organics in Water and Liquids (High Concentration)</u>		
All Organics Analysis	One 8-oz wide-mouth glass jar with Teflon-lined cap, filled 3/4 full	None required
<u>Inorganics in Water and Liquids (High Concentration)</u>		
All Inorganics Analysis	One 8-oz wide-mouth glass jar, filled 3/4 full	None required
Fluoride	One 500-ml polyethylene bottle filled to shoulder	None required
<u>Organics in Soil and Sediment (High Concentration)</u>		
All Organics Analysis	One 8-oz wide-mouth glass jar with Teflon-lined lid, filled 3/4 full	None required
<u>Inorganics in Soil and Sediment (High Concentration)</u>		
All Inorganics Analysis	One 8-oz wide-mouth glass jar, filled 3/4 full	None required
Fluoride	One 500-ml polyethylene bottle filled to shoulder	None required

¹All high-hazard sample bottles must be shipped in paint cans as hazardous

**Table 7.2 Required Sample Containers and Preservation¹
for Medium and Low Hazard Samples**

<u>Testing</u>	<u>Containers</u>	<u>Preservation</u>
<u>Organics in Water and Liquids (Medium Concentration)²</u>		
Extractables (acid, base/ neutral, pesticides/PCB)	Four 32-oz wide-mouth glass jars with Teflon- lined caps, filled to neck	None required
Volatiles	Two 40-ml VOA vials with Teflon-lined caps, com- pletely filled--no air bubbles	None required
<u>Inorganics in Water and Liquids (Medium Concentration)³</u>		
Metals	One 16-oz wide-mouth glass amber bottle; filled to shoulder	1:1 HNO ₃ to pH<2
Cyanide	One 16-oz wide-mouth glass amber bottle, filled to shoulder	6N NaOH to pH>12
Total Suspended Solids, Total Dissolved Solids	One 500-ml high density polyethylene bottle, filled to shoulder	None required
Minerals Acidity Alkalinity Chlorine Fluoride Sulfate	One 500-ml high-density polyethylene bottle, filled to shoulder	Cool 4°C Cool 4°C Room temperature Room temperature Cool 4°C
Nutrients Ammonia COD TKN NO ₃ -NO ₂ TOC Total Phosphorous	One 1-liter polyethylene bottle filled to shoulder	1 ml 1:1 H ₂ SO ₄ to pH<2, cool 4°C

Table 7.2 (Continued)

<u>Testing</u>	<u>Containers</u>	<u>Preservation</u>
<u>Organics in Soil and Sediment (Medium Concentration)</u>		
Extractables (acid, base/ neutral, pesticides/PCB)	One 8-oz, wide-mouth glass jar with Teflon- lined lid, filled about 3/4 full	None Required
Volatiles	Two 120-ml glass vials with Teflon-lined lid, filled as completely as possible	None Required
<u>Inorganics in Soil and Sediment (Medium Concentration)</u>		
Metals and Cyanide	One 8-oz, wide-mouth glass jar, filled about 3/4 full	None Required
<u>Organics in Water and Liquids (Low Concentration)</u>		
Extractables (acid, base/ neutral, pesticides/PCB)	Two 1/2-gal glass amber bottles with Teflon-lined caps, filled to neck	Iced to 4°C
Volatiles	Two 40-ml VOA vials with Teflon-lined caps, com- pletely filled--no air bubbles	Iced to 4°C
<u>Inorganics in Water and Liquid (Low Concentration)</u> ³		
Metals	One 1-liter high-density polyethylene bottle, filled to shoulder	11 HNO ₃ to pH<2
Cyanide	One 1-liter high-density polyethylene bottle, filled to shoulder	6N NaOH to pH>12
Total Suspended Solids, Total Dissolved Solids	One 500-ml high-density polyethylene bottle, filled to shoulder	None Required

Table 7.2 (Continued)

<u>Testing</u>	<u>Containers</u>	<u>Preservation</u>
Minerals		
Acidity	One 500-ml high-density polyethylene bottle, filled to shoulder	Cool 4°C
Alkalinity		Cool 4°C
Chloride		Room temperature
Fluoride		Room temperature
Sulfate		Cool 4°C
Nutrients		
Ammonia	One 1-liter polyethylene bottle filled to the shoulder	1 ml 11 H ₂ SO ₄ to pH<2, cool 4°C
COD		
TKN		
NO ₃ -NO ₂		
TOC		
Total Phosphorous		
<u>Organics in Soil and Sediment (Low Concentration)</u>		
Extractables (acid, base/neutral, pesticides/PCB)	One 8-oz, wide-mouth glass jar with Teflon-lined lid, filled about 3/4 full	Iced to 4°C
Volatiles	One 8-oz glass vial with Teflon-lined lid, fill as completely as possible	Iced to 4°C
<u>Inorganics in Soil and Sediment (Low Concentration)</u>		
Metals and Cyanide	One 8-oz, wide-mouth glass jar, filled about 3/4 full	Iced to 4°C (optional)

¹ All medium-hazard sample bottles must be shipped in paint cans marked as hazardous

² Water samples collected for duplicate analysis must be collected at double the volume specified for organics and inorganics. In addition, one volatile trip blank (distilled-deionized water poured directly into two 40-ml vials) should be supplied per shipment

³ If sample preservative is required, pH will be monitored to assure proper adjustment

8 SAMPLE DOCUMENTATION AND TRACKING

8.1 FIELD RECORDS

Field observations and other pertinent information pertaining to sample collection will be recorded in bound field notebooks using black ink. Data will be recorded on field data records contained in Appendix B of the Technical Data Management Plan and entered into the data base as described in the Technical Data Management Plan.

Notebooks shall be assigned to field personnel. Each notebook will be identified by a Document Control Number. The cover of the notebook will contain the following information: organization, book number, project name, start date, and end date.

8.2. CHAIN-OF-CUSTODY PROCEDURES

All samples will be collected and handled in accordance with the chain-of-custody procedures listed below:

- Samples will be kept in the possession or sight of at least one sampling team member at all times, unless transferred to a secure, locked area.
- A sample ID tag, including predesignated location ID and sample ID will be affixed in the field.
- Prior to relinquishing samples for packaging and shipment, one member of the sampling team will fill out a chain-of-custody record (Figure 8.1) for all team members to sign.
- If samples are stored temporarily prior to shipment, they will be kept cool and placed in a secured storage area. Coolers will be sealed and custody seals affixed just prior to shipment.
- If custody is transferred to the Shipping and Receiving Department at Rocky Flats Plant, the recipient will sign the chain-of-custody form.
- Shipping receipt for shipment by courier (above) should be retained and kept with one copy of the chain-of-custody form.

8 3 PHOTOGRAPHS

In addition to written records, photographs will be taken as needed to further clarify sampling activities. The film roll number and number of photographs taken at each sampling location will be noted.

Received By	Client	RFW Contact
Date	Client Contact	Date Due
Assigned to	Phone	Project Number

[illegible][illegible]

9 REFERENCES

- DOE 1986b "Comprehensive Environmental Assessment and Response Program Phase 1 Draft Installation Assessment Rocky Flats Plant," US Department of Energy unnumbered draft report, April 1986
- DOE 1986f "Resource Conservation and Recovery Act Part B - Operating Permit Application for USDOE Rocky Flats Plant, Hazardous and Radioactive Mixed Wastes," US Department of Energy unnumbered report, November 1986
- Hurr 1976 R T Hurr, "Hydrology of a Nuclear-Processing Plant Site, Rocky Flats, Jefferson County, Colorado," US Geological Survey Open-File report 76-268, 1976
- RI 1986a "Annual Environmental Monitoring Report January-December 1985," Rockwell International Rocky Flats Plant, Golden, Colorado report RFP-ENV-85, April 1986
- RI 1986b "Rocky Flats Plant Radioecology and Airborne Pathway Summary Report," Rockwell International, Rocky Flats Plant, Golden, Colorado unnumbered report, December 1986
- RI 1986c "Geological and Hydrological Data Summary, Rocky Flats Plant," Rockwell International, Rocky Flats Plant, Golden, Colorado unnumbered report, December 1986

APPENDIX 6

SITE CHARACTERIZATION PLAN;
ORIGINAL PROCESS WASTE LINES

SITE CHARACTERIZATION PLAN
USDOE ROCKY FLATS PLANT
ORIGINAL PROCESS WASTE LINES

OCTOBER 3, 1988

Submitted to:

Rockwell International
North American Aerospace Operations
Rocky Flats Plant
Golden, Colorado

Prepared by:

Chen & Associates, Inc
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1.0 INTRODUCTION

This soil sampling and analysis plan outlines field and laboratory investigations designed to provide an adequate data base for evaluating closure performance criteria for soil and determining acceptable closure alternatives for the original process waste lines (OPWL).

The closure alternatives for soil adjacent to the OPWL, which may have been contaminated by uncontrolled releases of process waste, are presented in Section 3.4.4 of the closure plan. Selection of the closure alternatives is based on the closure performance standards in Section 3.4.5 of the closure plan.

The soil sampling will be conducted in three phases.

- 1) Phase IA - Areas along the OPWL of known releases or possible contamination;
- 2) Phase IB - Areas along the OPWL of suspected releases; and
- 3) Phase IC - Areas along the OPWL of no known or suspected releases.

Within each phase, a soil characterization study will be implemented. The initial characterization will consist of qualitative investigation, such as direct radiation surveying, and quantitative analysis of soil samples from near the bottom of the pipe trench under investigation. Results of the initial investigation in each phase will determine the presence of (or lack of) soil contamination.

Additional characterization will be conducted in areas where contamination is detected. This aspect of the characterization study is designed to evaluate the lateral and vertical extent of contamination. Information from the characterization studies will provide input for design of the closure alternative to be implemented by the closure plan.

2.0 BACKGROUND

2.1 Facility Description

The OPWL consists of a system of tanks and associated lines beneath the ground surface and under buildings. The system was constructed to transport process wastes from point of origin to on-site treatment points. The OPWL was placed in service beginning in 1952. Additions to the system were completed through 1975, after which the OPWL was gradually replaced by the new process waste system. Further discussion of the system is provided in Section 1.2 of the OPWL closure plan.

The OPWL was first identified as a RCRA regulated unit in the summer of 1985 and remaining operable sections were subsequently abandoned. A closure plan for the OPWL is required pursuant to Part 270 and 264 of the Colorado State Hazardous Waste Regulations (6 CCR) and Title 40, Part 264 of the Code of Federal Regulations (40 CFR). This sampling plan is an integral part of

the closure plan for the OPWL, which is a part of the RCRA Post-Closure Permit Application (U.S. Department of Energy, 1988)

The OPWL requires soil characterization under this closure plan. Uncontrolled releases have occurred along portions of the abandoned lines. The approximate locations of the releases have been determined and are discussed in Sections 1.2.3.4 and 1.2.4.4 of the closure plan. Using the methods presented in this sampling plan, adjacent soils will be characterized for evaluation of closure alternatives and compliance with the closure performance standards.

2.2 Sampling Performed to Date

Soil samples were obtained and analyzed prior to September 1, 1976. The samples were obtained from areas of known leaks and repairs along the OPWL. The locations of the soil samples and the results of the analyses are presented in Table 3-1 (Section 3.4.3 of the closure plan). All soil samples were

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obtained from the bit of an auger after drilling to depths of approximately four feet.

Additional analyses are required to characterize the soil along the OPWL in order to evaluate closure alternatives. Rockwell International is currently preparing a plant-wide study to evaluate background concentrations to allow assessment of soil contamination from the OPWL.

3.0 SOURCE CHARACTERIZATION

The process wastes consisted of aqueous solutions with elevated nitrates, uranium -233, -234, and -238, and transuranics (plutonium -239 and americium -241). Also anticipated in the wastes are relatively small quantities of elevated metals and volatile organics. Further details of the waste characterization are presented in Section 1.2.2 of the OPWL closure plan.

If possible, waste samples will be obtained from the tanks and lines during closure and analyzed in accordance with the Waste Analysis Plan in Section C of the RCRA Part B Permit Application (USDOE, 1987a). Based on the known contaminants in the waste, and the results of any waste analyses, contaminant indicator parameters will be selected to characterize the presence of, and extent of, soil contamination from uncontrolled releases along the original process waste lines.

4.0 INDICATOR PARAMETERS FOR SOIL SAMPLING

Indicator parameters for soil sampling are discussed in Section 3.4.5.1 of the OPWL closure plan. The indicator parameter groups to be analyzed are summarized below:

- o Nitrates
- o Hazardous Substance List (HSL) Volatile Organics
- o Hazardous Substance List (HSL) Metals
- o Uranium
- o Transuranics

Nitrates are included since low-level radioactive wastes with high nitrate concentrations have been one of the forms of waste sent through the OPWL.

Volatile organics may have been transferred through the OPWL in small quantities. The specific volatile organics are unknown, therefore, all of the HSL volatile organics will be included as characterization indicator parameters.

Metals have been transferred through the OPWL; however, specific metals are not known. Therefore, all of the HSL metals have been selected for analysis in the characterization studies

Uranium is the only radionuclide that was considered representative of the wastes in the OPWL. The isotopes U-233, U-234, and U-238 have been selected as indicator parameters.

Plutonium is the only transuranic that is used on the site. However, americium is a daughter product of plutonium, and can be found at the Rocky Flats Plant due to ingrowth. Therefore, plutonium and americium have been selected as indicator parameters.

Further discussion regarding selection of indicator parameters is presented in Section 3.4.5.1 of the OPWL closure plan. Specific indicator parameters from the above groups are summarized in Table 4-1.

TABLE 4-1

SOIL CHARACTERIZATION INDICATOR PARAMETERS

o	Nitrate	
o	Uranium	
	U-233, 234 & 238	
o	Transuranics	
	Pu-239 & 240	
	Am-241	
o	HSL Metals	
	Antimony (SB)	
	Arsenic (As)	
	Barium (Ba)	
	Beryllium (Be)	
	Cadmium (Cd)	
	Lead (Pb)	
	Mercury (Hg)	
	Nickel (Ni)	
	Selenium (Se)	
	Silver (Ag)	
	Thallium (Tl)	
o	HSL Volatile Organics	
		<u>CAS Number</u>
	Chloromethane	74-87-3
	Bromomethane	74-83-9
	Vinyl Chloride	75-01-4
	Chloroethane	75-00-3
	Methylene Chloride	75-09-2
	Acetone	67-64-1
	Carbon Disulfide	75-15-01
	1,1-Dichloroethene	75-35-4
	1,1-Dichloroethane	75-35-3
	trans-1,2-Dichloroethene	156-60-5
	Chloroform	67-66-3

TABLE 4-1

SOIL CHARACTERIZATION INDICATOR PARAMETERS

o HSL Volate Organics (Continued)

	<u>CAS Number</u>
1,2-Dichloroethane	107-06-2
2-Butanone	78-93-3
1,1,1-Trichloroethane	71-55-6
Carbon Tetrachloride	56-23-5
Vinyl Acetate	108-05-4
Bromodichloromethane	75-27-4
1,1,2,2-Tetrachloroethane	79-34-5
1,2-Dichloropropane	78-87-5
trans-1,3-Dichloropropene	10061-02-6
Trichloroethene	79-01-6
Dibromochloromethane	124-48-1
1,1,2-Trichloroethane	79-00-5
Benzene	71-43-2
cis-1,3-Dichloropropene	10061-01-5
2-Chloroethyl Vinyl Ether	110-75-8
Bromoform	75-25-2
2-Hexanone	591-78-6
4-Methyl-2-pentanone	108-10-1
Tetrachloroethene	127-18-4
Toluene	108-88-3
Chlorobenzene	108-90-7
Ethyl Benzene	100-41-4
Styrene	100-42-5
Total Xylenes	100-42-5

5.0 SAMPLING PLAN

5.1 Analysis Rationale

Uncontrolled releases of process waste along the OPWL may have resulted in contamination of some adjacent soil. If the analyzed concentration of the soil characterization indicator parameters exceeds the closure performance level, action is required for closure to comply with applicable state and federal regulations. The closure performance standard for the OPWL, which presents concentration limits for the selected indicator parameters, is discussed in Section 3.4.5.2 of the OPWL closure plan. The concentration limits are summarized in Table 3-4 (Section 3.4.5.2 of the closure plan)

This soil sampling plan is designed to provide data on the level of soil contamination adjacent to the OPWL in order to evaluate the closure alternatives based on the closure performance standard. The overall sampling plan is divided into three phases according to areas of known releases, suspected releases, and "clean" areas as follows:

- 1) Phase IA - Areas along the OPWL of known releases;
- 2) Phase IB - Areas along the OPWL of suspected releases or potential contamination; and
- 3) Phase IC - Areas along the OPWL of no known or suspected releases.

Within each phase a characterization study will be conducted. The characterization will consist of direct radiation surveying and soil sampling to determine if contamination exists.

If any of the indicator parameter concentrations exceed the levels given in Table 3-4 (Section 3.4.5.2 of the closure plan) a subsequent characterization study will be conducted to evaluate the lateral and vertical extent of contamination.

In the areas of Phases IA and IB, initial characterization results that indicate "clean" conditions will be confirmed during subsequent characterization by reducing the sampling distance between the initial consecutive sample locations along the section of line under investigation. The purpose for confirmation of "clean" conditions during the subsequent characterization is to increase the statistical confidence level

of finding an isolated area of contamination in areas where releases have been reported or are otherwise suspected. Confirmation sampling will not be conducted in Phase 1C where initial indicator parameter concentrations are less than the performance levels.

5.2 Location of Sampling Points

5.2.1 Preliminary Characterization

Initial characterization will be conducted to determine the presence of contamination from uncontrolled releases. Methods used will include line verification, direct radiation survey and soil sampling. These methods use progressively refined screening procedures to effectively and efficiently locate contamination from uncontrolled releases of the OPWL.

5.2.1.1 Line Verification

Line locations will be verified using pits excavated by backhoe and hand methods. This will permit positive identification of the line, along with exact location and depth. Line locator devices can be attached to conductive pipe materials for surface location between pits. In nonconductive pipes, a conducting locator device can be inserted into the pipe after a section of pipe is removed. The pits will be spaced only as close as necessary to provide positive surface identification with locator devices. The pit excavations will be located to minimize interference with other utilities, structures, and plant operations.

In addition to locating the pipe, the excavations will provide information on visible contamination, extent of trench backfill, and the type of backfill material. This qualitative information will provide input for location of direct radiation surveys and soil sampling.

5.2.1.2 Direct Radiation Survey

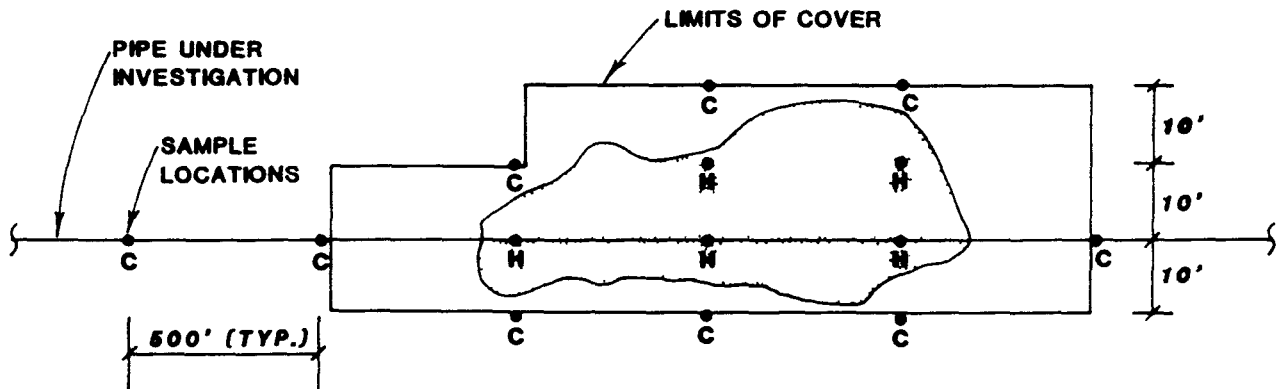
A direct radiation survey will be conducted over the ground to detect measurable amounts of radioactivity at or near the surface. The assessment will be conducted in accordance with Rocky Flats Radiation Monitoring Procedures (Rockwell, 1986). A Field Instrument for Detection of Low Energy Radiation or a Phoswich detector will be used to survey for radioactive contamination in the upper few centimeters of soil. The survey will cover the ground surface along the length of the pipe and ten feet in both directions transverse to the pipe. Levels will be documented by recording high and low values in each 200 square feet (20 feet transverse of the pipe by ten feet along the pipe). Readings will also be taken at locations that coincide with the preliminary soil sample locations proposed and will be recorded. Because of the limitations of the instrumentation for detecting low energy gamma radiation in situ, the laboratory analysis will provide the primary data for decision making. The Direct Radiation Survey will be done prior to sampling and will give some indication as to the extent of contamination near the

surface, and will be helpful in prescribing worker protection for the sampling.

5.2.1.3 Soil Sampling

The sampling points for the initial characterization will be located immediately adjacent to the line under investigation and within one foot below the springline of the pipe. Conceptual soil sampling locations are shown on Figure 5-1. The most likely location for adjacent soil contamination is in the trench backfill adjacent to and below, the pipe. The sand and backfilled soil is more permeable than the undisturbed surrounding soil. This results in a general tendency to promote lateral migration along the backfilled trench.

Reported releases were often documented with estimated flow rates typically ranging on the order of two gallons per minute. Based on this rate, and conservatively assuming the releases were not detected for up to eight hours, a reasonable release quantity of 1,000 gallons was calculated for estimating the size of the

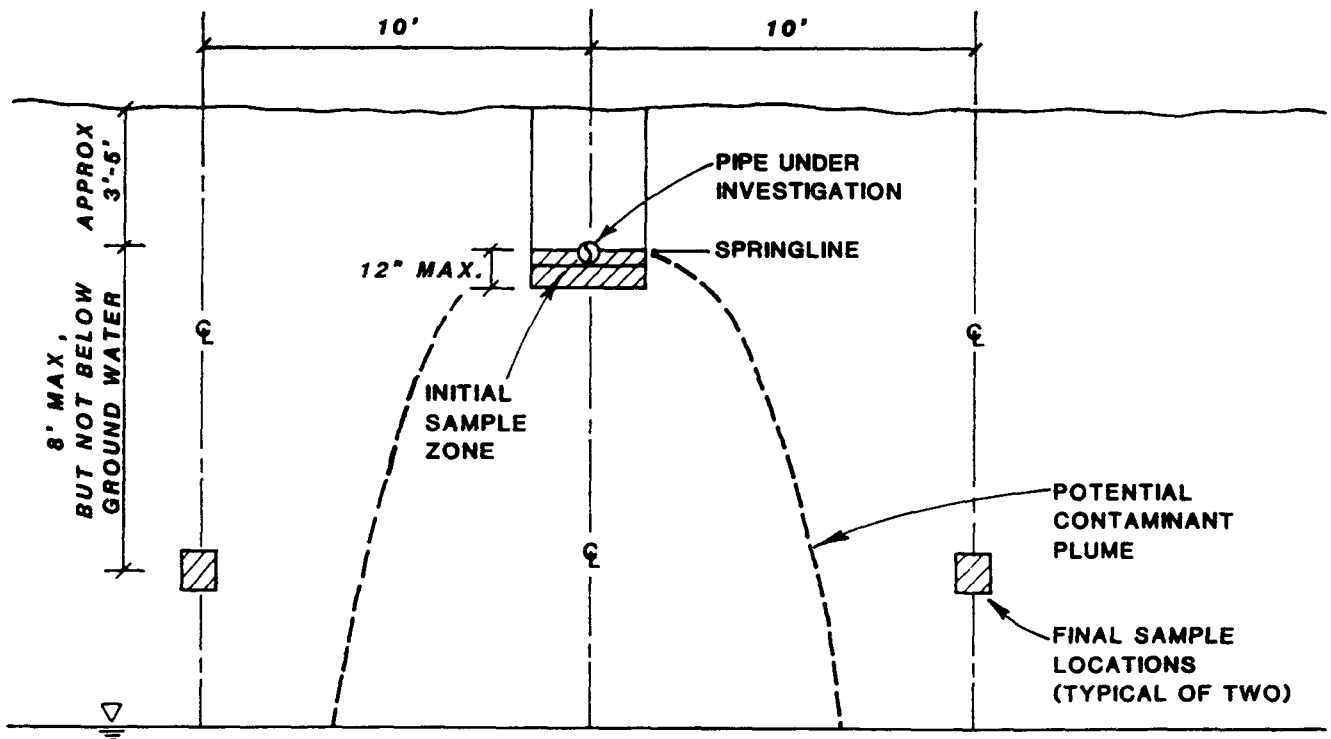


PLAN OF SAMPLE LOCATIONS

□ - **HYPOTHETICAL SOIL CONTAMINATION**

C - "CLEAN", SOIL SAMPLES MEET THE CLOSURE PERFORMANCE STANDARD FOR "NO ACTION"

H - HIT, SOIL SAMPLES DO NOT MEET THE CLOSURE PERFORMANCE STANDARD FOR "NO ACTION".



SECTION OF SAMPLE LOCATION

contaminated area that the soil sampling plan was designed to detect.

Assuming the release saturated the soil along the pipe in the bottom of the trench over an estimated width of three feet and a depth of 0.5 feet, using soil properties of 35 percent porosity, 115 pounds per cubic foot dry density and a moisture content of ten percent, the contaminated zone would extend 600 feet along the trench.

Based on this hypothetical assumption, the hole spacing for the initial characterization will be a maximum of 500 feet. Approximately 6,000 linear feet of pipe will be investigated in each of the three phases; Phase IA, IB, and IC. The location of each phase is identified on Plate I, Original Process Waste Lines Sample Location Map.

In Phase IA, initial locations of all holes are based upon the areas of known spills for the central hole, and 500-foot offsets as discussed above. At least one soil sample will be taken in each spill area. The tentative hole locations for Phase IA are

shown on Plate I. The final locations will be determined in the field based on nearby utility and building interferences.

Sample locations for Phases IB and IC will be determined after Phase IA is completed in order to determine the most effective sampling locations based on experience. The total of 18,000 feet of pipe trench will result in a minimum of 12 soil samples for the initial characterization in each of the three phases. (Note: The 18,000 feet of trench is estimated to include approximately 22,000 feet total length of pipe since some pipes are buried parallel to each other in the same trench.)

5.2.2 Final Characterization

5.2.2.1 Random Systematic Sampling

Results of the initial soil sampling will be evaluated and compared to the Level I closure performance standards in Table 3-4 (Section 3.4.5.2 of the closure plan). The evaluation will

determine if further soil analysis will be conducted to define the lateral extent of contamination and to evaluate further actions.

Phases IA and IB - At locations where soil contamination meets the closure performance standard between successive sampling locations, i.e. is "clean", the following decision logic applies.

For Phases IA and IB, where known and suspected releases have occurred, additional sampling during the final characterization at intermediate locations along the pipe will be implemented. The samples will be taken near the bottom of the pipe in the same manner as the initial characterization. Intermediate sampling will reduce the effective sample spacing along the pipe to 250 feet.

The reduced spacing will increase the statistical confidence level of locating a smaller zone of soil contamination. The effort to locate smaller zones of contamination for Phases IA and

IB is necessary since the area of these phases have an increased probability of being contaminated based on reported releases.

At locations where indicator parameter concentrations fail to meet the closure performance levels in Table 3-4 (Closure Plan Section 3.4.5.2), additional sampling will be conducted perpendicular to the pipe, and below the pipe, to determine the lateral and vertical extent of contamination.

Additional soil samples will be obtained transverse to the pipe near each identified contaminated sample location. The samples will be spaced at minimum ten-foot intervals perpendicular to the pipe, moving ten feet from the initial contaminated sample. These ten-foot sample events will be progressively located further from the pipe until "clean" conditions are encountered. A conceptual pattern of transverse sample spacing is shown on Figure 5-1. Additional longitudinal sampling along the pipe at 100-foot intervals may be implemented to refine the estimated length of soil contamination. This iterative sampling procedure will be conducted within the schedule time for each phase as discussed in Section 1.5.3 of the closure plan. The total

available time for all sampling and testing in each phase is eight months.

The contaminant migration path is assumed to be a downward percolation plume as shown on Figure 5-1. Therefore, samples will be taken at eight feet below the pipe, on each side of the pipe, to evaluate lateral contamination at depth. The average depth to bedrock over the OPWL is approximately 20 feet. Since the lines are three to five feet below the ground surface, the sample depth will be 11 to 13 feet deep. No additional sampling depths are necessary since the objective of the final characterization is to determine the lateral extent of contaminant migration. All samples will be taken above the ground water since contamination below the ground water will be addressed by ground-water corrective action.

The final characterization will continue in progressive increments until the extent of contaminated soil has been identified at each location.

Phase IC - For Phase IC, no further sampling will be performed at locations where the indicator parameter concentrations are less than the closure performance levels in Table 3-4 (Closure Plan Section 3.4.5.2).

If locations of contaminated soil that exceed the closure performance levels are encountered, additional sampling will be implemented as discussed above for Phase IA and IB areas.

5.2.2.2 Laboratory Analysis

The soil samples will be analyzed for all of the indicator parameters discussed in Section 4.0 and summarized in Table 4-1 of this site characterization plan.

5.3 Sampling Methodology

This section presents a discussion of the sampling procedures. The procedures are consistent with the CEARP phase 2:

Installation Generic Monitoring Plan (IGMP), Sampling Plan (Appendix 5 of the OPWL closure plan).

During the initial characterization, soil samples will be collected 12 inches below the springline of the pipe. Soil samples will be obtained in the pit excavations using a sledge hammer to drive a split-spoon sampler to a depth of six inches. Between pits, a truck mounted drill rig with continuous flight power auger will be used to obtain split-spoon drive samples from the bottom of an augered hole.

During final characterization, soil samples will be obtained eight feet below (and on either side of) the pipe using a truck mounted drill rig with continuous flight power auger and a split-spoon sampler.

Each soil sample will be place in a separate aluminum tray, and then placed in sample containers and labeled as required. After each soil sample is withdrawn, the split spoon sampler will be brushed off to remove excess soil and decontaminated. The split spoon will be decontaminated by scrubbing with tap water and

detergent solution, rinsed with tap water, rinsed with methanol, and finally rinsed with distilled water.

5.4 Sampling Equipment

The following list of equipment is anticipated for the activities outlined in this sampling plan:

Instrumentation

HNU photoionization detector
FIDLER probe for direct radiation survey

Protective Equipment

Tyvek suits
box of inner gloves
box of nitrile outer gloves
ultra twin/canister mask
organic vapor/dust cartridges or canisters
rolls of duct tape
100-foot measuring tape
boot covers

Sampling Equipment

logbook/waterproof ink pens/chain-of-custody sheets
watch
sample containers/labels
 8 oz. glass jars
 40 ml. VOA vials

1 liter cubitainers
80 oz. amber jugs
120 ml. glass jars
4 oz. bottles
bags vermiculite
plastic bags
rolls fiber tape
Nalgene disposable filters
boxes of garbage bags
sets of cooler labels
bags of ice
coolers
backhoe
split spoon sampler
sledgehammer
polyethylene sheeting
paper towels
shovel
plastic or metal scoops
distilled water
stainless steel buckets
aluminum trays
30 yds. disposable nylon rope
stakes and flagging
35 mm camera and film

Equipment for Decontamination

wash bucket
orchard sprayers
box of "alconox"
box of sanitizer (mask)
laboratory rinse bottles
waste solvent container
rinse bucket
alkaline detergent
brushes
paper towels/plastic trash bags
methanol
tap water
distilled water

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deionized water
tap water

6.0 SAMPLE CONTAINERS, PRESERVATION AND HOLD TIMES

Protocols for sample containers, sample preservation, and hold times will conform to those specified in the U.S. Department of Energy Comprehensive Environment Assessment and Response Program (CEARP) Phase 2: Installation Generic Monitoring Plan (IGMP) Sampling Plans and Quality Assurance/Quality Control Plans. The IGMP Sampling Plans and QA/QC Plans are presented in Appendices 5 and 7 of the closure plan.

A comprehensive site specific Quality Assurance/Quality Control Plan is being prepared by Rockwell International to address all remediation work at the plant site, including the closure activities for the original process waste lines. The QA/QC document will be completed in January, 1989.

7.0 SAMPLE CONTROL AND DOCUMENTATION

Procedures for sample control and documentation will conform to those specified in the U.S. Department of Energy Comprehensive Environmental Assessment and Response Program (CEARP) Phase 2 Installation Generic Monitoring Plan (IGMP) Sampling Plans and Quality Assurance/Quality Control Plans in Appendices 5 and 7 of the original process waste lines (OPWL) closure plan.

A comprehensive site specific Quality Assurance/Quality Control Plan is being prepared by Rockwell International to address all remediation work at the plant site, including the closure activities for the original process waste lines. The QA/QC document will be completed in January, 1989.

Field observations and other pertinent information pertaining to sample collection will be recorded in bound field notebooks using black ink. Notebooks will be assigned to field personnel. Each notebook will be identified by a Document Control Number. The cover of the notebook will contain the following information:

organization, book number, project name, start date, and end date.

All samples will be collected and handled in accordance with the chain-of-custody procedures listed below:

- Samples will be kept in the possession or sight of at least one sampling team member at all times, unless transferred to a secure, locked area.
- A sample I.D. tag, including predesignated location I.D. and sample I.D. will be affixed in the field.
- Prior to relinquishing samples for packaging and shipment, one member of the sampling team will fill out a chain-of-custody record for all team members to sign.
- If samples are stored temporarily prior to shipment, they will be kept cool and placed in a secured storage area. Coolers will be sealed and custody seals affixed just prior to shipment.
- If custody is transferred to the Shipping and Receiving Department at Rocky Flats Plant, the recipient will sign the chain-of-custody form.
- Shipping receipt for shipment by courier should be retained and kept with one copy of the chain-of-custody form.

In addition to written records, photographs will be taken as needed to further clarify sampling activities. The film roll

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number and number of photographs taken at each sampling location
will be noted.

8.0 SAMPLE HANDLING, TRANSPORT, AND STORAGE

Procedures for sample handling, transport, and storage will conform to those specified in the U.S. Department of Energy Comprehensive Environmental Assessment and Response Program (CEARP) Phase 2: Installation Generic Monitoring Plan (IGMP) Sampling Plans and Quality Assurance/Quality Control Plans in Appendices 5 and 7 of the original process waste lines (OPWL) closure plan.

A comprehensive site specific Quality Assurance/Quality Control Plan is being prepared by Rockwell International to address all remediation work at the plant site, including the closure activities for the original process waste lines. The QA/QC document will be completed in January, 1989.

9.0 SAMPLE PREPARATION AND ANALYSIS

Procedures for sample preparation and analyses will conform to those specified in the U.S. Department of Energy Comprehensive Environmental Assessment and Response Program (CEARP) Phase 2: Installation Generic Monitoring Plan (IGMP) Quality Assurance/Quality Control Plans in Appendix 7 of the original process waste lines (OPWL) closure plan.

A comprehensive site specific Quality Assurance/Quality Control Plan is being prepared by Rockwell International to address all remediation work at the plant site, including the closure activities for the original process waste lines. The QA/QC document will be completed in January, 1989

10.0 HEALTH AND SAFETY PLAN

Procedures for health and safety will conform to those specified in the U.S. Department of Energy Comprehensive Environmental Assessment and Response Program (CEARP) Phase 2: Installation Generic Monitoring Plan (IGMP) Health and Safety Plan. The IGMP Health and Safety Plan is presented in Appendix 8 of the OPWL Closure Plan.

A specific health and safety plan will be prepared at least two months before sampling begins and will be submitted to the Colorado Health Department for information. The Health and Safety Plan will also conform to the Rocky Flats Operational Safety Analysis (RFOSA) procedures, OSHA regulations, DOE orders and Rocky Flats Plant policies.

All field personnel will thoroughly review the site safety plan, understand the safety considerations and establish emergency procedures prior to site entry. All personnel must be subject to an active medical surveillance program and be authorized for use of respiratory protection.

Determination of appropriate level of protection should be made by surveillance with a HNU photoionization detector. Levels of protection criteria are summarized below:

Level D	<5 ppm above off-site ambient and nuisance odors
Level C	5 ppm above off-site ambient
Level B	5 ppm to 20 ppm
Leave Site	>20 ppm

All measurements are to be in the breathing zone. Protective clothing will be similar in nature to:

hardhats,
steel-toe boots,
overboots,
Tyvek suits,
dust masks, and
air-purifying respirators or self contained breathing
apparatus (optional)

The intent of this equipment is to provide a barrier to inhalation, ingestion and absorption of contaminated materials. Airborne contamination may require upgrading dust masks to air-purifying respirators or self-contained breathing apparatus.

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Skin contact with waste materials is a potential hazard. Tyveks and boot covers should be worn for general body protection. Gloves (nitrile or better) should be worn during sample collection and handling.

11.0 QUALITY ASSURANCE/QUALITY CONTROL

The protocol for quality assurance and quality control will conform to the U.S. Department of Energy Comprehensive Environmental Assessment and Response Program (CEARP) Phase 2: Installation Generic Monitoring Plan (IGMP) Quality Assurance/Quality Control Plan in Appendix 7 of the original process waste lines (OPWL) closure plan.

A comprehensive site specific Quality Assurance/Quality Control Plan is being prepared by Rockwell International to address all remediation work at the plant site, including the closure activities for the original process waste lines. The QA/QC document will be completed in January, 1989.

12.0 SCHEDULE

The schedule for implementing this sampling plan is discussed in Section 1.5.3 of the original process waste lines (OPWL) closure plan.

If required, because of changes in the closure plan, a revised soil sampling plan will be developed and submitted to the CDH for their approval within 90 days after determining changes to the sampling plan are required. The revised soil sampling plan will be part of the revised closure plan.

13.0 REFERENCES

- Rockwell, 1986: Rockwell International, July 28, 1986,
"Radiation Monitoring Procedures Manual", Rockwell
International, RMPM
- USDOE, 1987a: U.S. Department of Energy, December 15, 1987,
"RCRA Part B Operating Permit Application for U.S. DOE-
Rocky Flats Plant, Hazardous and Radioactive Mixed Wastes,"
CO7890010526, Revision No. 1.
- USDOE, 1987b: U.S. Department of Energy, February, 1987,
Comprehensive Environmental Assessment and Response Program,
Phase 2: Rocky Flats Plant, Installation Generic Monitoring
Plan (Comprehensive Source and Plume Characterization Plan),
Health and Safety Plan.
- USDOE, 1987c: U.S. Department of Energy, February, 1987,
Comprehensive Environmental Assessment and Response Program,
Phase 2: Rocky Flats Plant, Installation Generic Monitoring
Plan (Comprehensive Source and Plume Characterization Plan),
Sampling Plan.
- USDOE, 1987d: U.S. Department of Energy, February, 1987,
Comprehensive Environmental Assessment and Response Program,
Phase 2. Rocky Flats Plant, Site-Specific Monitoring Plan
(Work Plan for Performance of Remedial Investigations and
Feasibility Studies for all High-Priority Sites), Quality
Assurance/Quality Control Plan

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000298

Titled: APPENDIX 6 Original Process Waste Lines

Sample Location MAP Plate I

Fiche location: A-SW-M20

APPENDIX 7

CEARP PHASE 2: INSTALLATION GENERIC
MONITORING PLAN (IGMP);
QUALITY ASSURANCE/QUALITY CONTROL PLAN

DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATIONS OFFICE
ENVIRONMENT, SAFETY AND HEALTH DIVISION
ENVIRONMENTAL PROGRAMS BRANCH

COMPREHENSIVE ENVIRONMENTAL ASSESSMENT
AND RESPONSE PROGRAM

PHASE 2:
ROCKY FLATS-PLANT
INSTALLATION GENERIC MONITORING PLAN
(Comprehensive Source and Plume Characterization Plan)

QUALITY ASSURANCE/QUALITY CONTROL PLAN

February 1987

DRAFT

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QUALITY ASSURANCE/QUALITY CONTROL PLAN

1 INTRODUCTION

CEARP Phase 2 consists of CEARP Phase 2a Monitoring Plan, and CEARP Phase 2b Site Characterization (Remedial Investigation). This Quality Assurance/Quality Control (QA/QC) Plan is one component of the Monitoring Plan for Rocky Flats Plant. The Monitoring Plan typically consists of five parts: Synopsis, Sampling Plan, Technical Data Management Plan, Health and Safety Plan, and Quality Assurance/Quality Control Plan. Because of the Compliance Agreement made by the State of Colorado, Environmental Protection Agency, and the DOE, this Monitoring Plan also includes a Feasibility Study Plan. The Synopsis provides a discussion of the current situation and serves as an introduction to the other plans.

CEARP uses a three-tiered approach in preparing the monitoring plans: the CEARP Generic Monitoring Plan (CGMP) (DOE, 1986b), the Installation Generic Monitoring Plan (IGMP), and the Site-Specific Monitoring Plans (SSMPs). The CGMP Quality Assurance/Quality Control (QA/QC) Plan provides the generic guidelines and procedures that will be employed during CEARP Phase 2 site characterization (remedial investigation) to ensure the reliability of data collected at CEARP sites. It is intended to establish a general quality assurance/quality control policy and to provide the framework for more specific quality assurance/quality control requirements to be employed at each installation and at each site. This IGMP Quality Assurance/Quality Control Plan provides installation generic information and procedures, whereas the SSMPs will provide site-specific detail regarding locations, types, and number of samples.

This IGMP is the Comprehensive Source and Plume Characterization Plan required by the Compliance Agreement. Therefore, the acronym used to refer to this plan is IGMP/CSPCP.

According to DOE policy, DOE activities shall maintain programs of quality assurance (DOE Order 5700.6B). In the area of environmental protection, quality assurance plans must be integrated with the DOE implementation of CERCLA (DOE Order 5480.14).

CEARP Phase 2b site characterizations (remedial investigations) will be implemented using procedures to assure that the precision, accuracy, completeness, and representativeness of data are known and documented. At a minimum this will include adherence to the CEARP CGMP, IGMP/CSPCP, and SSMP Quality Assurance, Quality Control Plans, and may include preparation of written Quality Assurance, Quality Control Plans covering each aspect of the project performed.

This IGMP/CSPCP Quality Assurance/Quality Control Plan presents the organization, objectives, functional activities, and specific quality assurance and quality control activities associated with the CEARP Phase 2b site characterizations (remedial investigations) at Rocky Flats Plant. The Quality Assurance/Quality Control Plan is designed to achieve specific data quality goals for CEARP Phase 2b site characterizations (remedial investigations). Appendix A includes the quality assurance protocols for all laboratory services to be provided under CEARP Phase 2b site characterizations (remedial investigations).

A brief description of the CEARP Phase 2b site characterization (remedial investigation) and background can be found in the Synopsis. For a more in-depth background description, see the CEARP Phase 1 report.

2. PROJECT ORGANIZATION AND RESPONSIBILITY

Project organization and responsibility are divided among DOE, Los Alamos National Laboratory, and Rockwell International as described below. Los Alamos National Laboratory has the primary responsibility to implement CEARP under the guidance of DOE-Albuquerque Operations Office. However, operational responsibilities have been assigned to Rockwell International at Rocky Flats Plant for the site characterizations (remedial investigations). The DOE-Rocky Flats Plant Area Office is responsible for the function of the Rocky Flats Plant. Because of this responsibility, the DOE-Rocky Flats Plant Area Office will provide additional guidance to its contractor, Rockwell International, in implementation of the CEARP Phase 2b site characterizations (remedial investigations).

Project organization is shown in Figure 2.1. The responsibilities of the various personnel can be divided into operational, laboratory, and quality assurance responsibilities, as follows:

2.1. OPERATIONAL RESPONSIBILITIES

Assistant Secretary for the Environment The DOE Assistant Secretary for the Environment appoints Headquarters investigation boards and establishes the scope of Headquarters investigations (DOE Order 5484.1). DOE-wide Environmental Surveys and Audits originate from the Assistant Secretary.

Environmental Surveys and Audits Headquarters Environmental Survey Teams have been directed to conduct one-time environmental surveys and sampling of DOE facilities. These surveys are independent of CEARP activities at Rocky Flats Plant, but data from survey team sampling will be utilized in the CEARP characterization of Rocky Flats Plant. A Headquarters environmental survey team visited the Rocky Flats Plant site in 1986. The results of the survey will be used as an internal management tool by the Secretary and Undersecretary of DOE.

Audits are a function of the Office of the Assistant Secretary for the Environment. Audit teams provide quality control for the implementation of environmental monitoring at DOE facilities. Although independent of CEARP, audit teams complement CEARP activities by providing additional quality assurance.

DOE-Albuquerque Operations Office Environmental Programs Branch The DOE-Albuquerque Operations Office, Environmental Programs Branch, is responsible for overseeing all environmental programs within DOE-Albuquerque Operations and conducting special assessments such as CEARP

DOE-Rocky Flats Area Office The DOE Rocky Flats Area Office is responsible for the missions of the Rocky Flats Plant, including environmental protection. The DOE Rocky Flats Area Office oversees the integration of Rocky Flats Plant resources with CEARP activities at Rocky Flats Plant.

Rockwell International Rockwell International, as prime contractor to DOE, provides support to DOE in accomplishing the mission of Rocky Flats Plant, including environmental protection. Rockwell International will perform the CEARP Phase 2b site characterizations (remedial investigations) at Rocky Flats Plant.

Los Alamos National Laboratory Los Alamos National Laboratory manages the CEARP program, providing direction, oversight and review, and preparing final reports.

2.2. ANALYTICAL LABORATORY RESPONSIBILITIES

Analytical laboratory responsibilities include performing analytical services, and providing quality assurance. Rockwell International will perform the CEARP Phase 2b site characterizations (remedial investigations) at Rocky Flats Plant. This IGMP/CSPCP provides guidance for quality assurance programs to be implemented by

- field laboratory operations
- analytical laboratories
- geotechnical laboratories
- radiological laboratories

2.3 QA RESPONSIBILITY

Quality assurance responsibilities are to monitor and review the procedures used to perform all aspects of site characterizations (remedial investigations), including data collection, analytical services, data analysis, and report preparations. Primary responsibility for project quality rests with the Rockwell International CEARP Manager. Ultimate responsibility for project quality rests with DOE.

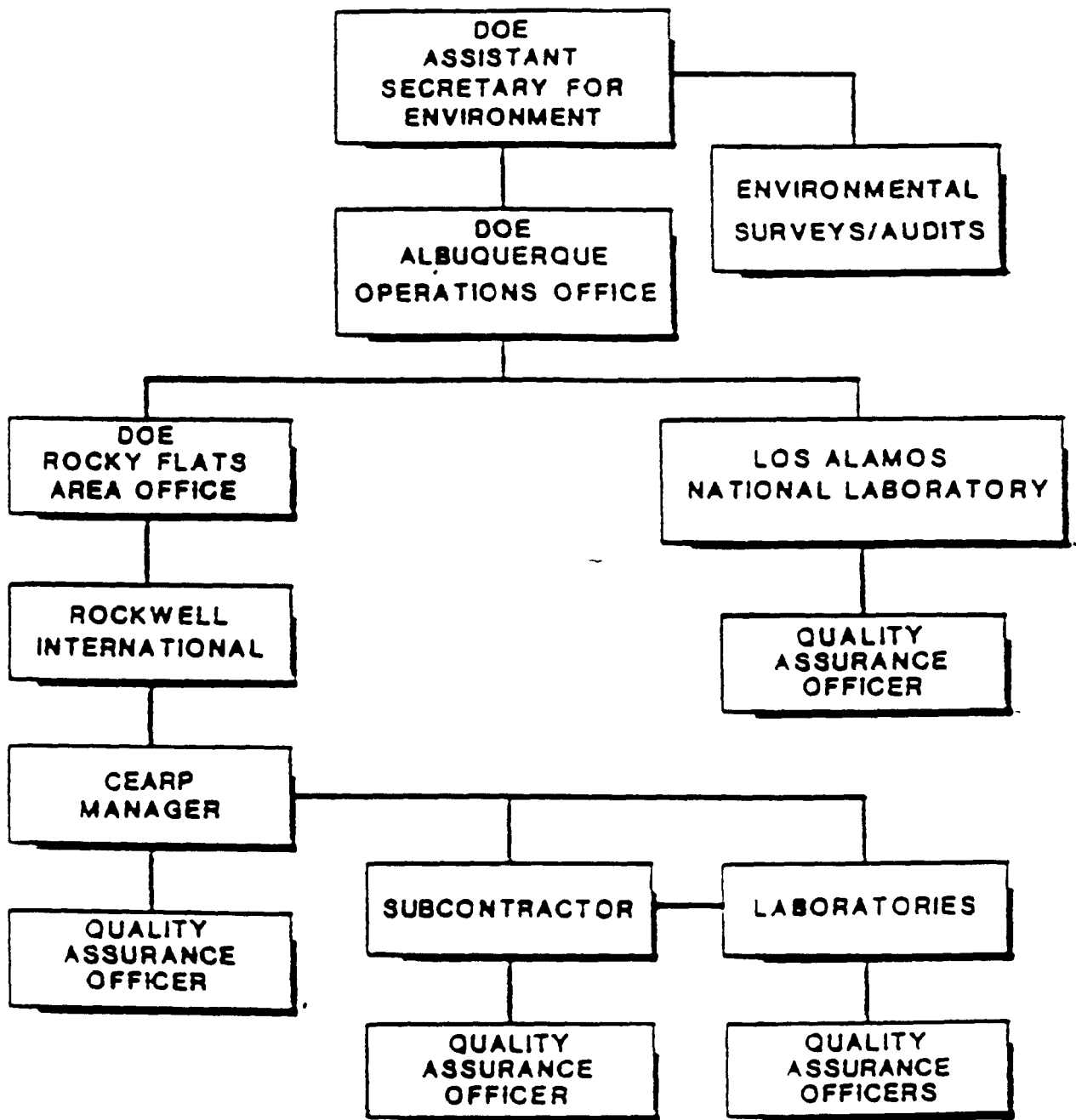


Figure 2.1 Quality Assurance/Quality Control Organization Chart

3. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall quality assurance objective is to develop and implement procedures for field sampling, field testing, chain of custody, laboratory analysis, and reporting that will assure quality as specified in DOE orders governing quality assurance and environmental protection. Specific procedures to be used for sampling, chain-of-custody, audits, preventive maintenance, and corrective actions are described in other sections of this IGMP Quality Assurance/Quality Control Plan. The purpose of this section is to define quality assurance goals for accuracy, precision and sensitivity of analysis, and completeness, representativeness, and comparability of measurement data from all analytical laboratories. Quality assurance objectives for field measurements are also discussed.

For some field activities, samples will not be collected, but measurements will be taken where quality assurance concerns are appropriate (e.g., field measurements of pH, temperature, and elevations). The primary quality assurance objective in activities where samples are not collected is to obtain reproducible measurements to a degree of accuracy consistent with their intended use and to document measurement procedures.

3.1. REGULATORY AND LEGAL REQUIREMENTS

Data used to evaluate compliance with the National Interim Primary Drinking Water Standards, State of Colorado water-quality standards, or water-quality criteria for agricultural or industrial use will have method detection limits as specified by the analytical method used, as appropriate.

3.2. LEVEL OF QUALITY ASSURANCE EFFORT

Field duplicates, field blanks, and trip blanks will be taken and submitted to the analytical laboratories to provide a means to assess data quality resulting from field sampling. Duplicate samples will be analyzed to check for sampling reproducibility. Field and trip blanks will be analyzed to check for procedural contamination and/or ambient site conditions that are causing sample contamination. Trip blanks will be analyzed to check for contamination during packaging and shipment.

Because volatile organic compounds are a class of contaminants most likely to be introduced to the sample by the sample container, there will be one trip blank per batch of samples designated for volatile organic compound analysis (shipping container). There will be one duplicate and one field blank for every 10 investigative samples collected. For laboratory organic analysis, matrix spikes and matrix spike duplicates will be used. The general level of quality assurance effort for organic analysis will be one matrix spike and one matrix spike duplicate prepared for every 20 samples of similar concentration and/or similar sample matrix, whichever is greater. In addition to field check samples, water samples of known concentration traceable to either EPA or NBS standards will be prepared for inorganic and radiological analyses. The general level of quality assurance effort for inorganic analyses will be one duplicate known sample and one duplicate field sample for every 10 investigative samples to check analytical reproducibility.

Soil samples selected for geotechnical testing will include one field duplicate for each 20 analyses being performed, if possible, but will not include blanks.

The groundwater, surface water, and soil samples collected at Rocky Flats Plant during CEARP Phase 2 will be analyzed using the analytical methods specified in Tables 3.1, 3.2, 3.3, and 3.4. The level of laboratory quality assurance effort will correspond to the procedures outlined in Appendix A.

3.3. ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSES

The fundamental quality assurance objective with respect to accuracy, precision, and sensitivity of laboratory analytical data is to achieve the quality control acceptance criteria of the analytical protocols. Sensitivities required for analyses of radionuclides, organics, metals, and other inorganic compounds, in both aqueous and solid matrices will be the detection limits shown in Tables 3.1, 3.2, 3.3, 3.4, 3.5, and 3.6. Achieving these detection limits depends on the sample matrix. Highly contaminated samples requiring dilution will have detection limits higher than those detected.

The accuracy of field laboratory measurements of groundwater and surface water pH will be assessed through pre-measurement calibrations and post-measurement verifications using at least two standard buffer solutions. The two measurements must each be within ± 0.05 standard units of buffer solution values. Precision will be

assessed through replicate measurements of every tenth sample. The standard deviation of four replicate measurements must be less than or equal to 0.1 standard units (The electrode will be withdrawn, deionized-rinsed and re-immersed between each replicate. The calibration and verification will be done before the first replicate and after the last replicate.) The instrument used will be capable of providing measurements to 0.01 standard units.

The geotechnical and field data will be considered accurate if the quality assurance criteria with respect to equipment, solutions, and calculations are met, and if adherence to appropriate methods can be documented during a systems audit.

3.4. COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

The laboratories will provide data meeting quality control acceptance criteria as described in Appendix A. Laboratories will provide completely valid data (IGMP/CSPCP QA/QC Plan, Section 8), the reasons for any variances from 100 percent completeness will be documented in writing.

3.5. FIELD MEASUREMENTS

Measurement data will be generated in many field activities. These activities may include, but are not limited to, the following:

- using geophysical surveys
- documenting time and weather conditions
- locating and determining the elevation of sampling stations
- measuring pH, conductivity, and temperature of water samples
- qualitative organic vapor screening of solid samples using a photoionization detector (PID) or an organic vapor analyzer (OVA)
- measuring water levels in a borehole or well
- standard penetration testing
- calculating pumping rates
- verifying well-development and presampling purge volumes
- performing hydraulic conductivity tests

The general quality assurance objective for such measurement data is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the intended use of the data through the documented use of standardized procedures. Procedures for performing these activities and standardized formats for documenting them are presented in the CGMP and IGMP/CSPCP Sampling Plans. These procedures may be incorporated by reference (EPA methods) or included as appendices. Standardized formats for documenting data collection are included in the Technical Data Management Plan.

Table 3.1 Analysis Plan for Aqueous Samples*

Analyte	Method	Detection Limit	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Unit
HSL Volatile	Ref 1	X ³	40 ml vial (2) w/teflon lined silicone rubber septum	40 ml	Cold, 4°C ⁹	14	ug/L
HSL Base/Neutral/Acid ¹	Ref 2	X ³	Amber G, 1L	1 L	Cold, 4°C ⁹	7/40 ⁷	ug/L
HSL Pesticide/PCB	Ref 3	X ³	Amber G, 1L	1 L	Cold, 4°C ⁹	7/40	ug/L
HSL Inorganic ²	EPA 200 ⁷	X ³	P, G, 1L	1 L	pH<2, w/HNO ₃ ⁹	180	ug/L
Cyanide	EPA 335 ⁸	X ³	P, G, 1L	0.5 L	pH>11, w/NaOH ⁹	14	ug/L
pH ⁴	EPA 150 ¹⁰	0.1 pH unit	P, G	N/A	None	Field Meas	pH unit
Sp Conductivity ⁴	EPA 120 ¹⁰	1	P, G	N/A	None	Field Meas	umho/cm
Temperature ⁴	EPA 170 ¹⁰	0.1	P, G	N/A	None	Field Meas	°C
Diss Oxygen ⁴	EPA 360 ¹⁰	0.5	G	N/A	None	Field Meas	mg/l
IDS	EPA 160 ⁸	5	P, G 1L	0.1 L	Cold 4°C ⁹	7	mg/l
ISS	EPA 160 ⁸	10	P, G 1L	0.1 L	Cold 4°C ⁹	7	mg/l
Total Phosphate	EPA 365 ⁴⁰	0.01	P, G 1L	1 L	Cold 4°C, pH<2 ⁹ w/H ₂ SO ₄	28	mg/l

Table 3.1 (Continued)

Analyte	Method	Detection Limit	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Unit
Chloride, Sulfate	EPA 352.2 ⁸ 375.2 ⁸	5	P, G, 1L	1 L	Cold 4°C ⁹	28	mg/l
Carbonate/Bicarbonate ⁵	S M 403 ⁶	10	P, G, 1L	1 L	Cold 4°C ⁹	14	mg/l
Nitrate	EPA 300.0 ⁸	5	P, G, 1L	1 L	Cold 4°C ⁹	2	mg/l
Hexavalent Chromium	S M 3128 ⁶	0.01	P, G, 1L	1 L	Cold 4°C ⁹	1	mg/l

¹The HSL Base/Neutral/Acid fractions analytical parameters are the HSL semi-volatiles

²Includes Cesium, Molybdenum, Strontium which are non HSL metals

³See Tables 3.5 and 3.6

⁴Field Measurements

⁵These are reported as carbonate and bicarbonate alkalinity

⁶Standard Methods for Examination of Water and Wastewater, 15th Edition

⁷7 days to extraction, analysis within 40 days of extraction

⁸Methods for Chemical Analysis of Water and Wastes, 1983, EPA 600/4-79-020

⁹All samples with the exception of VOA's will be filtered within 4 hours of sample collection and preservatives added to the filtrate as specified. All samples will be kept at 4°C until delivered to the laboratory

^aThe SSMP Sampling Plans will define the actual suite of parameters to be analyzed for specific samples

Method References

- Ref 1 Method 624 "Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water," EPA 600/4-82-057 plus additions, 1984
- Ref 2 Method 625 "Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water," EPA 600/4-82-057 plus additions, 1984
- Ref 3 Method 608 "Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water," EPA 600/4-82-057 plus additions, 1984

Table 3.2 Analysis Plan for Soil/Sediment/Waste Samples^a

Analyte	Method	Detection Limit	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Units
HSL Volatile	Ref 2	X ²	40 ml vial (2) w/teflon lined silicon rubber septa	5	Cold, 4°C	14	ug/kg
HSL Base/Neutral/Acid	Ref 3	X ²	Amber G, 1 L	10 30	Cold, 4°C	7/40 ³	ug/kg
HSL Pesticide/PCB	Ref 4	X ²	Amber G, 1 L	10 30	Cold, 4°C	7/40 ³	ug/kg
HSL Inorganic ¹	Ref 5	X ²	P G, 1 L	200	Cold, 4°C	180	mg/kg
Reactivity	Ref 6	Ref 8	Amber G		Cold 4°C	N/A	ug/l
EP Toxicity	Ref 7	Ref 9	Amber G	100 g	Cold 4°C	N/A	ug/l in leachate
Chloride	EPA 300 0 ⁵	60 ug/g ⁶	G, 1 L	20	Cold, 4°C	N/A	mg/kg
Sulfate	EPA 300 0 ⁵	60 ug/g ⁶	G, 1 L	20	Cold, 4°C	N/A	mg/kg
Nitrate	EPA 300 0 ⁵	60 ug/g ⁶	G, 1 L	20	Cold, 4°C	N/A	mg/kg
Cyanide	Ref 1	X ²	G, 1 L	200	Cold, 4°C	14	mg/kg
Hexavalent Chromium	S M 312B ⁷	1 ug/g ⁶	G, 1 L	100	Cold 4°C	1	mg/kg

¹Includes Cesium, Molybdenum, and Strontium which are non HSL metals²See Tables 3.5 and 3.6³Extract within 7 days, analysis within 40 days of extraction⁴Reported as dry weight, % moisture reported separately⁵Soil/Sediments will be leached with Laboratory Reagent Water (20 g soil to 50 ml water) and water extract analyzed using referenced procedure⁶Method for Chemical Analysis of Water and Wastes, 1983, EPA 600/4-79-020

Procedure reference

Table 3 2 (Continued)

⁶These are estimated detection limits

⁷Soil/sediment will be leached with Laboratory Reagent Water (5 g soil and 100 ml of water) by shaking for 2 hours, and the water extract filtered and subsequently analyzed. This is in accordance with method 312B in Standard Methods for Examination of Water and Wastewater, 15th Edition

*The SSMP Sampling Plans will define the actual suite of parameters to be analyzed for specific samples

Method References

- | | | |
|-------|------------------------------------|--|
| Ref 1 | Method 9010 | "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984 |
| Ref 2 | Method 8240 | "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984 |
| Ref 3 | Method 8270 | "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984 |
| Ref 4 | Method 8080 | "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984 |
| Ref 5 | Method 6010 or 7000 Series Methods | "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response Washington, DC 20460, Revised April 1984 |
| Ref 6 | Method 9010, 9030 | "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460 Revised April 1984 |
| Ref 7 | Method 1310 | "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984 |

Table 3.3 Analysis Plan for Radiological Analysis for Aqueous Samples

Analyte	Method	Detection Limit	Sample Container	Sample Volume	Preservation	Holding Time (days)	Reporting Unit
Gross alpha/beta	1,2,3,4,6,7,8,9	Gross alpha = 2 pCi/L	P, 1 gal	0.2 L	HNO ₃ to pH <2	180	pCi/L
Tritium	1,2,3,6	400 pCi/L	G, 100 ml	0.008 L	No preservation	NA	pCi/L
Pu 239	10,11	0.3 pCi/L	P, 1 gal	1.000 L	HNO ₃ to pH <2	180	pCi/L
Am 241	11,12	0.4 pCi/L	P, 1 gal	1.000 L	HNO ₃ to pH <2	180	pCi/L
Isotopic U	1,3,4,7,8,9	U 233 + 234 = 0.6 pCi/L U 238 = 0.6 pCi/L	P, 1 gal	0.500 L	HNO ₃ to pH <2	180	pCi/L
Sr 90	1,3,4,6	1 pCi/L	P, 1 gal	1.000 L	HNO ₃ to pH <2	180	pCi/L

*See Attachment 1

**See Attachment 2

ATTACHMENT 1

Method References

- 1 US Environmental Protection Agency 1979 Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No EMSL-LY-0539-1, Las Vegas, NV US Environmental Protection Agency
- 2 American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985 Standard Methods for the Examination of Water and Wastewater, 16th ed., Washington, D.C., Am Public Health Association
- 3 U.S. Environmental Protection Agency, 1976. Interim Radiochemical Methodology for Drinking Water, Report No EPA-600/4-75-008 Cincinnati US Environmental Protection Agency
- 4 Harlev, J. H., ed. 1975, HASL Procedures Manual, HASL-300, Washington D.C. US Energy Research and Development Administration
- 5 Misaqi, Fazlallah L., Monitoring Radon-222 Content of Mine Waters Informational Report 1026, US Department of Interior, Mining Enforcement and Safety Administration, Denver, CO, 1975
- 6 "Radioassay Procedures for Environmental Samples," 1967, USDHEW, Section 7-2-3
- 7 "Handbook of Analytical Procedures," USAEC, Grand Junction Lab 1970, page 196
- 8 "Prescribed Procedures for Measurement of Radioactivity in Drinking Water EPA-600/4-80-032, August 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, US Environmental Protection Agency, Cincinnati, Ohio 45268
- 9 "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," USGS Book 5, Chapter A5, 1977
- 10 "Acid Dissolution Method for the Analysis of Plutonium in Soil." EPA-600/7-79-081, March 1979, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979
- 11 "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium and Americium," by E. H. Essington and B. J. Drennon Los Alamos National Laboratory, a private communication
- 12 "Isolation of Americium from Urine Samples." Rocky Flats Plant, Health, Safety, and Environmental Laboratories

ATTACHMENT 2

Lower Limits of Detection

The detection limits presented were calculated using the formula in NRC Regulatory Guide 4.14, Appendix Lower Limit of Detection, pg. 21 and follow

$$LLD = 4.66 \frac{BKG^{1/2}}{DUR} \sqrt{(2.22) (Eff) (CR) (SR) (e^{-\lambda t}) (Aliq)},$$

Where

LLD	=	Lower Limit of Detection in pCi per sample unit
BKG	=	Instrument Background in counts per minute (cpm)
DUR	=	Duration of sample counting in minutes
Eff	=	Counting efficiency in cpm/disintegration per minute (dpm)
CR	=	Fractional radiochemical yield
SR	=	Fractional radiochemical yield of a known solution
λ	=	The radioactive decay constant for the particular radionuclide
t	=	the elapsed time between sample collection and counting

In that LLD is a function of many variables including sample matrix, sample volume, and other factors, the limits presented are only intended as guides to order-of-magnitude sensitivities and, in practice, can easily change by a factor of two or more even for the conditions specified.

Table 3.4 Analysis Plan for Radiological Analysis for Soils/Sediments

Analyte	Method ^a	Detection Limit ^a	Sample Container	Sample Size (g)	Preservations	Holding Time (days)	Reporting Unit
Gross alpha/beta	1,2,3,4,6,7,8,9	Gross a = 4 pCi/g Gross b = 10 pCi/g		0.1	NA	NA	pCi/g
Pu 239	10,11	0.3 pCi/g	G, 1 L	1	NA	NA	pCi/g
Am 241	11,12	0.3 pCi/g	G, 1 L	1	NA	NA	pCi/g
Isotopic U	1,3,4,7,8,9	U 233 + 234 = 0.3 pCi/g U 238 = 0.3 pCi/g	G, 1 L	1	NA	NA	pCi/g
Sr 90	1,3,4,8	1 pCi/g	G, 1 L	1	NA	NA	pCi/g

^aSee Attachment 1

^aSee Attachment 2

ATTACHMENT I

Method References

- 1 U.S. Environmental Protection Agency, 1979, Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No EMSL-LY-0539-1, Las Vegas, NV, U.S. Environmental Protection Agency
- 2 American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985 Standard Methods for the Examination of Water and Wastewater, 16th ed., Washington, D.C., Am. Public Health Association
- 3 U.S. Environmental Protection Agency, 1976 Interim Radiochemical Methodology for Drinking Water, Report No EPA-600/4-75-008 Cincinnati U.S. Environmental Protection Agency
- 4 Harley, J. H., ed., 1975, HASL Procedures Manual, HASL-300, Washington D.C. U.S. Energy Research and Development Administration
- 5 Misaqi, Fazlilleh L., Monitoring Radon-222 Content of Mine Waters Informational Report 1026, U.S. Department of Interior, Mining Enforcement and Safety Administration, Denver, CO, 1975
- 6 "Radioassay Procedures for Environmental Samples," 1967, USDHEW, Section 7.2.3
- 7 "Handbook of Analytical Procedures," USAEC, Grand Junction Lab 1970, page 196.
- 8 "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, August 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268
- 9 "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," USGS Book 5, Chapter A5, 1977
- 10 "Acid Dissolution Method for the Analysis of Plutonium in Soil," EPA-600/7-79-081, March 1979, U.S. EPA Environmental Monitoring and Support Laboratory Las Vegas, Nevada, 1979
- 11 "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium Uranium and Americium," by E. H. Essington and B. J. Drennon Los Alamos National Laboratory, a private communication
- 12 "Isolation of Americium from Urine Samples," Rocky Flats Plant, Health, Safety, and Environmental Laboratories

ATTACHMENT 2

Lower Limits of Detection

The detection limits presented were calculated using the formula in NRC Regulatory Guide 4.14 Appendix Lower Limit of Detection pg 21, and follow

$$LLD = 4.66 \frac{BKG^{1/2}}{DUR (2.22) (Eff) (CR) (SR) (e^{-\lambda t}) (Aliq)}.$$

Where

- LLD = Lower Limit of Detection in pCi per sample unit
- BKG = Instrument Background in counts per minute (cpm)
- DUR = Duration of sample counting in minutes
- Eff = Counting efficiency in cpm/disintegration per minute (dpm)
- CR = Fractional radiochemical yield
- SR = Fractional radiochemical yield of a known solution
- λ = The radioactive decay constant for the particular radionuclide
- t = the elapsed time between sample collection and counting

In that LLD is a function of many variables including sample matrix, sample volume, and other factors, the limits presented are only intended as guides to order-of-magnitude sensitivities and, in practice, can easily change by a factor of two or more even for the conditions specified

Table 3.5 Hazardous Substance List (HSL) and Contract Required
Detection Limits (CRDL)**

Volatiles	CAS Number	Detection Limits*	
		Low Water ³ ug/L	Low Soil Sediment ⁴ ug/Kg
1 Chloromethane	74-87-3	10	10
2 Bromomethane	74-83-9	10	10
3 Vinyl Chloride	75-01-4	10	10
4 Chloroethane	75-00-3	10	10
5 Methylene Chloride	75-09-2	6	5
6 Acetone	67-64-1	10	10
7 Carbon Disulfide	75-15-01	5	5
8 1,1-Dichloroethene	75-35-4	5	5
9 1,1-Dichloroethane	75-35-3	5	5
10 trans-1,2-Dichloroethene	156-60-5	5	5
11 Chloroform	67-66-3	5	5
12 1,2-Dichloroethane	107-06-2	5	5
13 2-Butanone	78-93-3	10	10
14 1,1,1-Trichloroethane	71-55-6	5	5
15 Carbon Tetrachloride	56-23-5	5	5
16 Vinyl Acetate	108-05-4	10	10
17 Bromodichloromethane	75-27-4	5	5
18 1,1,2,2-Tetrachloroethane	79-34-5	5	5
19 1,2-Dichloropropane	78-87-5	5	5
20 trans-1,3-Dichloropropene	100061-02-6	5	5
21 Trichloroethene	79-01-6	5	5
22 Dibromochloromethane	124-48-1	5	5
23 1,1,2-Trichloroethane	79-00-5	5	5
24 Benzene	71-43-2	5	5
25 cis-1,3-Dichloropropene	10061-01-5	5	5
26 2-Chloroethyl Vinyl Ether	110-75-8	10	10
27 Bromoform	75-25-2	5	5
28 2-Hexanone	591-78-6	10	10
29 4-Methyl-2-pentanone	108-10-1	10	10
30 Tetrachloroethene	127-18-4	5	5
31 Toluene	108-88-3	5	5
32 Chlorobenzene	108-90-7	5	5
33 Ethyl Benzene	100-41-4	5	5
34 Styrene	100-42-5	5	5
35 Total Xylenes	100-42-5	5	5

Table 3.5 (Continued)

Semi-Volatiles	CAS Number	Detection Limits*	
		Low Water ^c ug/L	Low Soil/Sediment ^d ug/Kg
36 N-Nitrosodimethylamine	62-75-9	10	330
37 Phenol	108-95-2	10	330
38 Aniline	62-53-3	10	330
39 bis(2-Chloroethyl) ether	111-44-4	10	330
40 2-Chlorophenol	95-57-8	10	330
41 1,3-Dichlorobenzene	541-73-1	10	330
42 1,4-Dichlorobenzene	106-46-7	10	330
43 Benzyl Alcohol	100-51-6	10	330
44 1,2-Dichlorobenzene	95-50-1	10	330
45 2-Methylphenol	95-48-7	10	330
46 bis(2-Chloroisopropyl ether	39638-32-9	10	330
47 4-Methylphenol	106-44-5	10	330
48 N-Nitroso-Dipropylamine	621-64-7	10	330
49 Hexachloroethane	67-72-1	10	330
50 Nitrobenzene	98-95-3	10	330
51 Isophorone	78-59-1	10	330
52 2-Nitrophenol	88-75-5	10	330
53 2,4-Dimethylphenol	105-67-9	10	330
54 Benzoic Acid	65-85-0	50	1600
55 bis(2-Chloroethoxy) methane	111-91-1	10	330
56 2,4-Dichlorophenol	120-83-2	10	330
57 1,2,4-Trichlorobenzene	120-82-1	10	330
58 Naphthalene	91-20-1	10	330
59 4-Chloroaniline	106-47-8	10	330
60 Hexachlorobutadiene	87-68-3	10	330
61 4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
62 2-Methylnaphthalene	91-57-6	10	330
63 Hexachlorocyclopentadiene	77-47-4	10	330
64 2,4,6-Trichlorophenol	88-06-2	10	330
65 2,4,5-Trichlorophenol	95-95-4	50	1600
66 2-Chloronaphthalene	91-58-7	10	330
67 2-Nitroaniline	88-74-4	50	1600
68 Dimethyl Phthalate	131-11-3	10	330
69 Acenaphthylene	208-96-8	10	330
70 3-Nitroaniline	99-09-2	50	1600

Table 3.5 (Continued)

Semi-Volatiles	CAS Number	Detection Limits*	
		Low Water ¹ ug/L	Low Soil Sediment ¹ ug Kg
71 Acenaphthene	83-32-9	10	330
72 2,4-Dinitrophenol	51-28-5	50	1600
73. 4-Nitrophenol	100-02-7	50	1600
74 Dibenzofuran	132-64-9	10	330
75 2,4-Dinitrotoluene	121-14-2	10	330
76 2,6-Dinitrotoluene	606-20-2	10	330
77 Diethylphthalate	84-66-2	10	330
78 4-Chlorophenyl Phenyl ether	7005-72-3	10	330
79 Fluorene	86-73-7	10	330
80 4-Nitroaniline	100-01-6	50	1600
81 4,6-Dinitro-2-methyl- phenol	534-52-1	50	1600
82 N-nitrosodiphenylamine	86-30-6	10	330
83 4-Bromophenyl Phenyl ether	101-55-3	10	330
84 Hexachlorobenzene	118-74-1	10	330
85 Pentachloropphenol	87-86-5	50	1600
86 Phenanthrene	85-01-8	10	330
87 Anthracene	120-12-7	10	330
88. Di-n-butylphthalate	84-74-2	10	330
89 Fluoranthene	206-44-0	10	330
90 Benzidine	92-87-5	50	1600
91 Pyrene	129-00-0	10	330
92 Butyl Benzyl Phthalate	85-68-7	10	330
93 3,3'-Dichlorobenzidine	91-94-1	20	660
94 Benzo(a)anthracene	56-55-3	10	330
95 bis(2-ethylhexyl) phthalate	117-81-7	10	330
96 Chrysene	218-01-9	10	330
97 Di-n-octyl Phthalate	117-84-0	10	330
98 Benzo(b)fluoranthene	205-99-2	10	330
99 Benzo(k)fluoranthene	207-08-9	10	330
100 Benzo(a)pyrene	50-32-8	10	330
101 Indeno(1,2,3-cd)pyrene	193-39-5	10	330
102. Dibenz(a,h)anthracene	53-70-3	10	330
103 Benzo(g,h,i)perylene	191-24-2	10	330

Table 3.5 (Continued)

Pesticides	CAS Number	Detection Limits ^a	
		Low Water ^b ug/L	Low Soil/Sediment ^c ug/Kg
104 alpha-BHC	319-84-6	0.05	8.0
105 beta-BHC	319-85-7	0.05	8.0
106 delta-BHC	319-86-8	0.05	8.0
107 gamma-BHC (Lindane)	58-89-9	0.05	8.0
108 Heptachlor	76-44-8	0.05	8.0
109 Aldrin	309-00-2	0.05	8.0
110 Heptachlor Epoxide	1024-57-3	0.05	8.0
111 Endosulfan I	959-98-8	0.05	8.0
112 Dieldrin	60-57-1	0.10	16.0
113 4,4'-DOE	72-55-9	0.10	16.0
114 Endrin	72-20-8	0.10	16.0
115 Endosulfan II	33213-65-9	0.10	16.0
116 4,4'-DDD	72-54-8	0.10	16.0
117 Endrin Aldehyde	7421-93-4	0.10	16.0
118 Endosulfan Sulfate	1031-07-8	0.10	16.0
119 4,4'-DDT	50-29-3	0.10	16.0
120 Endrin Ketone	53494-70-5	0.10	16.0
121 Methoxychlor	72-43-5	0.5	80.0
122 Chlordane	57-74-9	0.5	80.0
123 Toxaphene	8001-35-2	1.0	160.0
124 AROCLOR-1016	12674-11-2	0.5	80.0
125 AROCLOR-1221	11104-28-2	0.5	80.0
126 AROCLOR-1232	11141-16-5	0.5	80.0
127 AROCLOR-1242	53469-21-9	0.5	80.0
128 AROCLOR-1248	12672-29-6	0.5	80.0
129 AROCLOR-1254	11097-69-1	1.0	160.0
130 AROCLOR-1260	11096-82-5	1.0	160.0

^aMedium Water Contract Required Detection Limits (CRDL) for Volatile HSL Compounds are 100 times the individual Low Water CRDL

^bMedium Soil/Sediment Contract Required Detection Limits (CRDL) for Volatile HSL Compounds are 100 times the individual Low Soil/Sediment CRDL.

^cMedium Water Contract Required Detection Limits (CRDL) for Semi-Volatile HSL Compounds are 100 times the individual Low Water CRDL

^dMedium Soil/Sediment Contract Required Detection Limits (CRDL) for Semi-Volatile HSL Compounds are 60 times the individual Low Soil/Sediment CRDL

Table 3.5 (Continued)

*Medium Water Contract Required Detection Limits (CRDL) for Pesticide HSL

Compounds are 100 times the individual Low Water CRDL

*Medium Soil/Sediment Contract Required Detection Limits (CRDL) for Pesticide
HSL compounds are 60 times the individual Low Soil/Sediment CRDL

*Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, as required by the contract, will be higher.

**These are the EPA detection limits under the Contract Laboratory Program. Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable.

Table 3.6 Elements Determined by Inductively Coupled
Plasma Emission or Atomic Absorption Spectroscopy

<u>Element</u>	<u>Contract Required Detection Level^{1,2} (ug/L)</u>
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	5
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cesium	200
Molybdenum	40
Strontium	200
Cyanide	10

Note: Detection limits in soil/sediment are numerically equivalent to those listed above with concentration units of mg/kg.

¹ Higher detection levels may also be used in the following circumstances.

If the sample concentration exceeds two times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the contract required detection limit. This is illustrated in the example below:

Table 3.6 (Continued)

For lead

Method in use - ICP

Instrument Detection Limit (IDL) = 40

Sample Concentration = 85

Contract Required Detection Limit (CRDL) = 5

The value of 85 may be reported even though instrument detection limit is greater than required detection level. The instrument or method detection limit must be documented.

²These CRDL are the instrument detection limits obtained in pure water met using the procedure in Exhibit E. The detection limits for samples may be considerably higher depending on the sample matrix.

4 SAMPLING PROCEDURES

Procedures for collecting samples and for performing all related field activities are described in detail in Appendix A of the IGMP/CSPCP Sampling Plan. Adherence to these procedures will be confirmed by the CEARP Quality Assurance Officers (Rockwell International and subcontractor) by quality assurance audits.

5. SAMPLE CUSTODY

CEARP field custody procedures are described in Section 7.2 of the IGMP/CSPCP Sampling Plan. Laboratory custody procedures for the analytical laboratories are described in Appendix A.

6. CALIBRATION PROCEDURES AND FREQUENCY

Standard commercial calibration procedures will be used by the analytical laboratories, as specified in Appendix A

Calibration of equipment used to perform geotechnical testing will be in accordance with that specified in the ASTM Method D 422-63 for hydrometer and sieve analyses (Annual Book of ASTM Standards, Volume 04 08, 1984) The equipment calibrations, including those for ovens, thermometers and balances, shall be done at a minimum of every six months and prior to large scale testing

Field instruments will be calibrated according to procedures presented in Appendixes A and B of the IGMP/CSPCP Sampling Plan A calibration log book will be assigned to each field instrument, and all calibrations will be documented in the log books

7. ANALYTICAL PROCEDURES

Laboratory analyses will follow methods described in Tables 31, 32, 33, and 34. Deviation from those methods, if required, will be presented in the SSMPs.

8. DATA REDUCTION, VALIDATION, AND REPORTING

Analytical laboratories will provide results to the Rockwell International CEARP Manager, the Subcontractor Project Manager, and Quality Assurance Officers. These data will include results and documentation for blanks and duplicates, matrix spikes, and forms summarizing analytical precision and accuracy.

Analytical data, including quality control sample analysis, will be entered into the technical data base. The analyses will be grouped into lots, with quality control samples associated with a particular lot. The analyses of quality control samples will be compared to theoretical known concentrations of those samples. If analyses do not meet acceptance criteria, the analytical laboratory may be asked to re-analyze the samples for parameters which do not exceed holding times. Analyses which cannot meet acceptance criteria, will be labelled as unacceptable. All parameter-specific values for a lot in which the quality control analyses did not meet acceptance criteria, will be removed from the technical data base.

Acceptance criteria for analyses of parameters for quality control samples (knowns) will be based on the theoretical known value furnished by the laboratory that prepared the sample. The theoretical known value is stated as a range of values. The analysis of the sample must be within the stated range of the theoretical known plus or minus 10% of the range. An exception is analyses at or near the limit of detection. If the lower limit of the range of the theoretical known value is less than twice the limit of detection, an acceptable analysis includes the range from the limit of detection to the upper limit of the theoretical range, plus 10%.

Analytical reports from a field laboratory, if used, and the geotechnical laboratory will include all raw data, documentation of reduction methods, and related quality assurance/quality control data. These data will be assessed by verification of reduction results and confirmation of compliance with quality assurance/quality control requirements.

Raw data from field measurements and sample collection activities used in project reports will be appropriately identified. Where data have been reduced or summarized, the method of reduction will be documented.

The Quality Assurance Officers will review results of Quality Control-acceptance evaluations and will document acceptance or non-acceptance of data. The Quality Assurance Officers will maintain records of quality control-acceptance tests. These records will be subject to independent audit, which may include Los Alamos National Laboratory.

9. INTERNAL QUALITY CONTROL PROCEDURES

Internal quality control procedures for the laboratory are those specified in Appendix A. These specifications include types of audits required (e.g., sample spikes, surrogate spikes, reference samples, controls, and blanks), frequency of audits, compounds to be used for sample spikes and surrogate spikes, and quality control acceptance criteria for audits.

The quality control checks and acceptance for data from a field laboratory, if used, and the geotechnical laboratory are described above in Sections 3.2 and 3.3. Quality control procedures for field measurements (pH, conductivity, and temperature) are limited to checking the reproducibility of the measurement in the field by obtaining multiple readings and/or by calibrating the instruments (where appropriate). Quality control of field sampling will involve collecting field duplicates and blanks.

10. PERFORMANCE AND SYSTEMS AUDITS

For each activity where samples are collected, a performance audit investigating conformance with quality control procedures will be conducted (Appendix A) at the discretion of the Rockwell International CEARP manager, Subcontractor Project Manager, and Quality Assurance Officers. This audit will be scheduled to allow oversight of as many different field activities as possible. This audit will be performed by the Quality Assurance Officers or their designees. A written report of the results of this audit, along with a notice of nonconformity (if necessary), will be submitted to the following individuals.

- Rockwell International CEARP Manager
- Subcontractor Project Manager
- Subcontractor Site Manager

At least one systems audit will be performed during the project. The audit will verify that a system of quality control measures, procedures, reviews, and approvals was established for all activities and is being used by project personnel. It will also verify that the system for project documentation is being used and that all quality control records, along with required quality control reviews, approvals, and activity records are being maintained. A standard checklist for systems audits will be used. The systems audit will be conducted by the Quality Assurance Officers and/or Los Alamos National Laboratory. A final report will be prepared which summarizes any deviations from approved methods and their impacts on the project results.

After consultation with the CEARP Manager (and Subcontractor Project Manager), the Quality Assurance Officers may schedule systems audits of the participating laboratories. At a minimum, the systems audit would include inspection of laboratory notebooks, control sheets, logsheets, computer files, and equipment calibration and maintenance records. If scheduled, system audits will be executed by individuals identified in Section 2.3 of this document.

Performance and systems audits of analytical laboratories will be scheduled and executed by the laboratory Quality Assurance Officers. Performance audits are conducted at least semiannually.

11. PREVENTIVE MAINTENANCE

This section applies solely to field equipment. Preventive maintenance will be addressed by checks of equipment prior to initiation of field operations to allow time for replacement of malfunctioning equipment. The Subcontractor Site Manager will be responsible for implementing and documenting these procedures on a weekly basis during the period of use.

12. LABORATORY DATA ASSESSMENT PROCEDURES

Analytical data from laboratories is assessed for accuracy, precision and completeness by the laboratory Quality Assurance Officers, using standard procedures

Assessment of data generated by analytical laboratories is initiated and continued at three administrative levels. The bench chemist directly responsible for the test knows current operating acceptance limits. He/she can directly accept or reject generated data and consult with his/her immediate supervisor for any corrective action. Once the bench chemist has reported the data as acceptable he/she initials the report sheet. Any out-of-control results are flagged and a note is made as to why the results were reported.

The chief chemist receives the data sheets and reviews the quality control data that accompanied the sample run. After checking the reported data for completeness and quality control results, the chief chemist either initials the report sheet or sends it back to the bench chemist for rerunning of samples. The Quality Control Coordinator reviews data forwarded to him/her as acceptable by the chief chemist. Any remaining out-of-control results that, in the opinion of the Quality Control Coordinator, do not necessitate rerunning of the sample, are flagged, and a memo is written to the data user regarding utility of the data. Data generated from all analyses are given a final review by the laboratory Quality Assurance Officers.

13. CORRECTIVE ACTION PROCEDURES

The Quality Assurance Officers and their audit teams will prepare a report describing the results of the performance and/or system audits. If unacceptable conditions (e.g., failure to have/use procedures), unacceptable data nonconformity with the quality control procedures, or a deficiency are identified the Quality Assurance Officers will notify the Rockwell International CEARP Manager of the results of the audit in writing. They will also state if the nonconformity is of significance for the program and recommend appropriate corrective actions. The Rockwell International CEARP Manager will be responsible for ensuring that corrective is developed and initiated and that, if necessary, special expertise not normally available to the project team is made available. The subcontractor will be responsible for carrying out corrective actions. The subcontractor will also ensure that additional work is not performed until the nonconformity is corrected. Corrective action may include

- reanalyzing the samples if holding time permits,
- resampling and reanalyzing,
- evaluating and amending the sampling and analytical procedures, and
- accepting the data and acknowledging its level of uncertainty

The Rockwell International CEARP Manager will be responsible for ensuring that corrective action was taken, and that it adequately addressed the nonconformity.

After corrective action is taken, the Quality Assurance Officer responsible for the audit will document its completion in a written report. The report will indicate any identified findings, corrective action taken, follow-up action, and final recommendations. The report will be sent to the Rockwell International CEARP Manager. Project staff will be responsible for initiating reports on suspected nonconformities in field activities and deliverables or documents.

14. QUALITY ASSURANCE REPORTS

The Rockwell International CEARP Manager will rely on written reports, memoranda documenting data assessment activities, performance and systems audits, nonconformity notices, corrective action reports, and quality assurance notices to enforce quality assurance requirements. The Los Alamos National Laboratory will be issued a written quality assurance report at the end of each stage of site characterization (remedial investigation) by the Rockwell International CEARP Manager.

Records will be maintained to provide evidence of quality assurance activities. Proper maintenance of quality assurance records is essential to provide support for evidential proceedings and to assure overall quality of the investigation. A quality assurance records index will be started at the beginning of the project. All information received from outside sources or developed during the project will be retained by the project team. Upon termination of an individual task or work assignment, working files will be processed for storage as quality assurance records. Upon termination of the project, complete documentation records (for example, chromatograms, spectra, and calibration records) will be archived as required by DOE Order 1324 2A (Records Deposition). The Rockwell International CEARP Manager and the Los Alamos National Laboratory CEARP Rocky Flats Plant Team Leader will be responsible for ensuring that the Quality Assurance records are being properly stored and that they can be retrieved.

15. REFERENCES

DOE 1986b: "Comprehensive Environmental Assessment and Response Program Phase
1. Draft Installation Assessment Rocky Flats Plant," US Department of Energy
unnumbered draft report, April 1986

APPENDIX A

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

1. LABORATORY QA/QC PROGRAM

This appendix to the quality assurance/quality control plan describes the organization and procedures used to produce reliable analytical data. These procedures are applicable to performing chemical, radiological, and geotechnical analyses on waste or environmental samples as appropriate.

The ultimate responsibility for the generation of reliable laboratory data rests with the laboratory management. Laboratory management is vested with the authority to establish those policies and procedures to ensure that only data of the highest attainable caliber are produced. Laboratory management, as well as the laboratory Quality Assurance/Quality Control Officer are responsible for the implementation of the established policies and procedures.

Laboratory management has the following responsibilities:

- direct implementation of the quality assurance program.
- ensure that their personnel are adequately trained to perform analyses,
- ensure that equipment and instrumentation under their control are calibrated and functioning properly, and
- review and perform subsequent corrective action on internal and external audits.

The Quality Assurance/Quality Control Officer has the following responsibilities:

- on-going review of individual quality assurance procedures
- providing assistance in the development and implementation of specific quality assurance plans for special analytical programs.
- coordination of internal and external quality assurance audits,
- coordination of quality assurance training,
- review of special project plans for consistency with organizational requirements and advising laboratory management of inconsistencies, and
- overall coordination of the laboratories' quality assurance program manual.

1 2. SAMPLE MANAGEMENT

On notification of the sampling and analyses effort, the laboratory will create a file to maintain records associated with the activity. In addition to administrative information, requests for sample containers, preservatives, and required analyses will be included in the file.

Sample bottles will be prepared by the laboratory and made available to the sampling team. The bottles will be prepared according to the analysis plan procedures and will include sample preservatives appropriate to the analytes and matrices of concern. Addition of preservatives to sample shall be recorded on chain-of-custody forms.

Samples received at the laboratories will be inspected for integrity, and any field documentation will be reviewed for accuracy and completeness.

Chain-of-custody and sample integrity problems will be noted and recorded on the chain-of-custody forms during sample log-in. Chain-of-custody forms and deficiency notices will be maintained in the file. Any deficiencies will be brought to the attention of the Rockwell International CEARP Manager who will advise the laboratory on the desired disposition of the samples.

Each sample that is received by the laboratory will be assigned a unique sequential sample number which will identify the sample in the laboratory's internal tracking system. References to a sample in any communication will include the assigned sample number.

Samples will be stored in a locked refrigerator at 4°C. The temperature of the storage refrigerators will be monitored and recorded daily by the sample custodian. Sample fractions and extracts will also be stored under these same conditions.

1.3. ANALYTICAL SYSTEMS

1.3.1. Instrument Maintenance

Instruments will be maintained in accordance with manufacturers' specifications. More frequent maintenance may be dictated dependent on operational performance. Instrument logs will be maintained to document the date, type, and reason for any maintenance performed.

Contracts on major instruments with manufacturers and service agencies may be used to provide routine preventive maintenance and to ensure rapid response to emergency repair service.

1.3.2. Instrument Calibration

Before any instrument is used, it will be calibrated using known reference materials. All sample measurements will be made within the calibrated range of the instrument. A record of calibration will be kept in an equipment log.

1.3.3. Personnel Training

Prior to conducting analyses on an independent basis, analysts will be trained by experienced personnel in the complete performance of the analytical method. Analysts may require training at instrument manufacturers' training courses. The analyst will be required to independently generate data on several method and/or matrix spikes to demonstrate proficiency in that analytical method. The type of data to be generated will be dependent on the analytical method to be performed. Results of this "certification" will be reviewed by laboratory management for adequacy.

Method blanks and method spikes will be required in every lot of samples analyzed, thus performance on a day-to-day basis can be monitored. Laboratory management and the Laboratory Quality Assurance/Quality Control Officer are responsible for ensuring that samples are analyzed by only competent analysts.

1.4. ANALYTICAL METHODS

1.4.1 Gas Chromatography/Mass Spectroscopy

Mass spectrometers will be tuned on a daily basis to manufacturer's specifications with FC-43. In addition, once per shift (8 hours) these instruments will be tuned with decafluorotriphenylphosphine (DFTPP) or 4-bromo-fluorobenzene (BFB) for semi-volatiles or volatiles, respectively. Ion abundance will be within the window dictated by the requirements of the specific protocols. Once an instrument has been tuned, initial calibration curves for analytes (appropriate to the analyses to be performed) will be generated for at least three solutions containing known concentrations of authentic standards of compounds of concern.

The calibration curve will bracket the anticipated working range of analyses.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

During each operating shift, a midpoint calibration standard will be analyzed to verify that the instrument responses are still within the initial calibration determinations. The calibration check compounds will be those analytes used in the EPA contract laboratory program's multicomponent analyses (e.g., priority pollutants and hazardous substances list) with the exception that benzene will be used in place of vinyl chloride (volatiles) and di-n-octyl phthalate will be deleted from the semi-volatile list.

The response factor drift will be calculated and recorded. If significant (>30%) response factor drift is observed, appropriate corrective action will be taken to restore confidence in the instrumental measurements.

All GC/MS analyses will include analyses of a method blank, a method spike and a method spike duplicate in each lot of samples. In addition, appropriate surrogate compounds specified in EPA methods will be spiked into each sample. Recoveries from method spikes and surrogate compounds will be calculated and recorded on control charts to maintain a history of system performance.

Duplicate samples will be analyzed for analytical lots of twenty (20) or more samples

Audit samples will be analyzed periodically to compare and verify laboratory performance against standards prepared by outside sources.

1.4 2. Gas Chromatography and High Performance Liquid Chromatography

Gas chromatographs and high performance liquid chromatographs will be calibrated prior to each day of use. Calibration standard mixtures will be prepared from appropriate reference materials and will contain analytes appropriate for the method of analysis.

Working calibration standards will be prepared fresh daily. The working standards will include a blank and a minimum of three concentrations to cover the anticipated range of measurement. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of "known" versus "found" concentrations must be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be obtained, additional standards must be analyzed to define the calibration curve. A midpoint calibration check standard will be analyzed each operating shift (8 hours) to confirm the validity of the initial calibration curve. The check standard must be within twenty (20) percent of the initial response curve to demonstrate that the initial calibration curve is still valid.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory. The method spikes will be examined to determine both precision and accuracy.

Accuracy will be measured by the percent recovery of the spikes, precision will be measured by the reproducibility of method spikes

1 4.3. Atomic Absorption Spectrophotometry

Atomic absorption spectrophotometers will be calibrated prior to each day of use

Calibration standards will be prepared from appropriate reference materials, and working calibration standards will be prepared fresh weekly. The working standards will include a blank and a minimum of five concentrations to cover the anticipated range of measurement.

Duplicate injections will be made for each concentration. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of "known" versus "found" concentrations will be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to analysis of samples. Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory and will be introduced at a frequency of one per analytical lot or five (5) percent of the samples, whichever is more. The method spikes will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery of the spikes. The recovery must be within the range of 75-125 percent to be considered acceptable.

Precision will be measured by the reproducibility of both method spikes. Results must agree within twenty (20) percent in order to be considered acceptable.

1.4.4. Spectrophotometric Methods

Spectrophotometers will be calibrated prior to each day of use. Calibration standards will be prepared from reference materials appropriate to the analyses being performed, and working standards will include a blank and a minimum of five (5) concentrations to cover the anticipated range of measurement. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of "known" versus "found" concentration will be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to the analysis of samples.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory.

Accuracy will be measured by the percent recovery of the spikes. The recovery must be in an acceptable range (based on EPA data for the method of interest) in order to be considered acceptable. Precision will be measured by the reproducibility of both method spikes.

Results must agree within acceptable limits (based on EPA data) in order to be considered acceptable.

1.5. REFERENCE MATERIALS

Whenever possible, primary reference materials will be obtained from the National Bureau of Standards (NBS) or the U.S. Environmental Protection Agency (EPA). In absence of available reference materials from these organizations, other reliable sources may be sought. Reference materials will be used for instrument calibrations, quality control spikes, and/or performance evaluations. Secondary reference material

may be used for these functions provided that they are traceable to an NBS standard or have been to an NBS standard within the laboratory

1.6. REAGENTS

Laboratory reagents will be of a quality to minimize or eliminate background concentrations of the analyte to be measured. Reagents must also not contain other contaminants that will interfere with the analyte of concern.

1.7. CORRECTIVE ACTIONS

When an analytical system is deemed to be questionable or out-of-control at any level of review, corrective action will be taken. If possible, the cause of the out-of-control situation will be determined, and efforts will be made to bring the system back into control. Demonstration of the restoration of a reliable analytical system will normally be accomplished by generating satisfactory calibration and/or quality control sample data. The major consideration in performing corrective action will be to ensure that only reliable data are reported from the laboratory. The Rockwell International CEARP Manager will be informed of the problem and all corrective actions taken.

1.8. DATA MANAGEMENT

1.8.1. Data Collection

All data will be recorded in laboratory notebooks. Laboratory notebooks will contain

- Date and time of processing
- Sample numbers
- Project
- Analyses or operation performed
- Calibration data
- Quality control samples included
- Concentrations/dilutions required
- Instrument readings
- Special observations
- Analyst's signature.

Copies of laboratory notebooks will be provided to the Rockwell International CEARP Manager on request.

1.8.2. Data Reduction

Data reduction will be performed by the individual analysts. The complexity of the data reduction will be dependent on the specific analytical method and the number of discrete operations (extractions, dilutions, and concentrations) involved.

For those methods utilizing a calibration curve, sample responses will be applied to the linear regression line to obtain an initial raw result which will be factored into equations to obtain the estimate of the concentration in the original sample. Rounding will not be performed until after the final result is obtained, to minimize rounding errors, and results will not normally be expressed in more than two (2) significant figures.

Copies of all raw data and the calculations used to generate the final results will be retained in the laboratory file to allow reconstruction of the data reduction process at a later date. Copies of these records will be provided to the Rockwell International CEARP Manager on request.

1.8.3. Data Review

System reviews will be performed at all levels. The individual analyst will review the quality of data through calibration checks, quality control sample results and performance evaluation samples. These reviews will be performed prior to submission of data to the laboratory management.

Laboratory management will review data for consistency and validity to determine if program requirements have been satisfied. Selected hard copy output of data (chromatograms, spectra, etc.) will be reviewed to ensure that results are interpreted correctly. Unusual or unexpected results will be reviewed, and a resolution will be made as to whether the analysis should be repeated. In addition, laboratory management will recalculate selected results to verify the calculation procedure. Any abnormalities will be brought to the attention of the Rockwell International CEARP Manager.

The Quality Assurance Officer will independently conduct a complete review of results from randomly selected samples to determine if laboratory and program quality assurance/quality control requirements have been met. Deviations from requirements will be reported to the laboratory management and Rockwell International CEARP Manager for resolution.

Non-routine audits may be performed.

1.8.4. Data Reporting

Reports will contain final results (uncorrected for blanks and recoveries), methods of analysis, levels of detection, surrogate recovery data, and method blanks data. In addition, special analytical problems, and/or any modifications of referenced methods will be noted. The number of significant figures reported will be consistent with the limits of uncertainty inherent in the analytical method. Consequently, most analytical results will be reported to no more than two (2) significant figures.

Data will be reported in units commonly used for the analyses performed. Concentrations in liquids will be expressed in terms of weight per unit volume (e.g., milligrams per liter). Concentrations in solid or semi-solid matrices will be expressed in terms of weight per unit weight of sample (e.g., micrograms per grams).

Reported detection limits will be those specified by the analytical method.

1.8.5 Data Archiving

The laboratory will maintain on file all of the raw data (including calibration data), laboratory notebooks, and other pertinent documentation. This file will be maintained at the laboratory for a period of time consistent with Rocky Flats Plant's requirements. At the end of that time frame, all these records will be given to Rocky Flats Plant.

2. PERFORMANCE AND SYSTEM AUDITS

Quality assurance audits will be conducted. System audits will be conducted at random, unscheduled intervals at least annually.

Audits will be planned, organized, and clearly defined before they are initiated. Auditors will identify nonconformances or deficiencies. These will be reported and documented so that corrective actions can be initiated through appropriate channels. Corrective actions will be followed up with a compliance review. A report on each audit will be sent to the Rockwell International CEARP Manager.

2.1. FIELD AUDITS

Unannounced field audits, investigating conformance with QA/QC procedures, will be performed. A typical checklist for this type of audit is shown in Table A-1. A written report on the results of this audit will be submitted to the Rockwell International CEARP Manager.

2.2. CORRECTIVE ACTION

After each audit, auditors will identify nonconformances in a written nonconformance notice and initiate corrective action through the Rockwell International CEARP Manager. The nonconformance notice will describe any nonconforming conditions and set a date for response and corrective action(s). The Subcontractor Project Manager will prepare a written proposal for corrective action for review and approval by the Rockwell International CEARP Manager. When approved the proposed corrective action(s) will be implemented. Follow-up review will be performed by the auditor to confirm that the corrective actions have been implemented.

Table A 1 Field Audit

Project _____ Site Manager _____
 Site Location _____ Field Team Leader _____
 Auditor _____ Date _____

Audit Question	Yes	No	Comment/Documentation
1. Was a site-specific sampling and analytical plan followed?			
2. Was a field team leader appointed?			
3. Was the site health and safety coordinator present?			
4. Were field team members familiar with the sampling plan?			
5. Was a briefing held offsite, before any site work was begun, to acquaint personnel with sampling equipment and assign field responsibilities?			
6. Was the daily briefing and safety check conducted?			
7. Was a completed "Site Personnel Protection and Safety Evaluation Form" read and signed by all visitors and personnel entering the site?			
8. Was a field notebook assigned to the field team leader?			
9. Were entries made in the field notebook?			
10. Were sampling stations located correctly?			
11. Did the number and location of samples collected follow the site-specific sampling plan?			

Table A 1 (Continued)

Project _____ Site Manager _____
 Site Location _____ Field Team Leader _____
 Auditor _____ Date _____

Audit Question Yes No Comment/Documentation

- 12 Were samples identified as described in the site-specific sampling plan?
- 13 Were samples collected following procedures specified in the site-specific plan?
- 14 Was a chain-of-custody form filled out for all samples collected? Were all sample transfers documented?
- 15 Were samples preserved as specified in the site-specific sampling plan?
- 16 Were the number, frequency, and type of samples (including blanks and duplicates) collected as described in the site-specific sampling plan?
- 17 Were the number, frequency, and type of measurements and observations taken as specified in the site-specific sampling plan?
- 18 Were blank and duplicate samples properly identified?
- 19 Was a record maintained of calibration of field equipment?
- 20 Was field equipment calibrated as required?

Table A.1 (Continued)

Project _____ Site Manager _____
 Site Location _____ Field Team Leader _____
 Auditor _____ Date _____

Audit Question	Yes	No	Comment/Documentation
21. Have any procedures been revised?			
22. Are revisions to procedures adequately documented?			
23. Was the document log for chain-of-custody records and other sample traffic control forms maintained?			
24. Have any accountable documents been lost?			
25. Did drilling and well construction follow procedures outlined in the sampling plan?			
26. Were the activities being conducted compatible with the environmental conditions?			

APPENDIX 8

CEARP PHASE 2: INSTALLATION GENERIC MONITORING PLAN (IGMP);
HEALTH AND SAFETY PLAN

**DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATIONS OFFICE
ENVIRONMENT, SAFETY AND HEALTH DIVISION
ENVIRONMENTAL PROGRAMS BRANCH**

**COMPREHENSIVE ENVIRONMENTAL ASSESSMENT
AND RESPONSE PROGRAM**

**PHASE 2:
ROCKY FLATS PLANT
INSTALLATION GENERIC MONITORING PLAN
(Comprehensive Source and Plume Characterization Plan)**

HEALTH AND SAFETY PLAN

February 1987

DRAFT

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1. INTRODUCTION

CEARP Phase 2 Confirmation consists of CEARP Phase 2a, Monitoring Plan, and CEARP Phase 2b, Site Characterization (Remedial Investigation). This Health and Safety Plan is one component of the Monitoring Plan for Rocky Flats Plant. The Monitoring Plan consists of five parts: Synopsis, Sampling Plan, Technical Data Management Plan, Health and Safety Plan, and Quality Assurance/Quality Control Plan. Because of the Compliance Agreement made by the State of Colorado, Environmental Protection Agency, and Department of Energy (DOE), this Monitoring Plan also includes a Feasibility Study Plan. The Synopsis provides a discussion of the current situation and serves as an introduction to the other plans.

CEARP uses a three-tiered approach in the preparation of monitoring plans: the CEARP Generic Monitoring Plan (CGMP), the Installation Generic Monitoring Plan (IGMP), and the Site-Specific Monitoring Plans (SSMPs). This IGMP is the Comprehensive Source and Plume Characterization Plan required by the compliance agreement. Therefore, the acronym used to refer to this plan is IGMP/CSPCP.

This IGMP/CSPCP Health and Safety Plan incorporates the specific safety practices and procedural review requirements for Rocky Flats Plant.

The CGMP Health and Safety Plan provides generic guidance and establishes procedures for conducting site characterization (remedial investigation) activities under CEARP Phase 2. It outlines how the DOE-Albuquerque Operations Office will implement health and safety requirements under CEARP. Specifically, it provides generic guidelines and procedures that will be employed by Rocky Flats Plant and Los Alamos National Laboratory during CEARP Phase 2b site characterization (remedial investigation) activities to protect the health and safety of personnel involved in CEARP. Thus, the CGMP Health and Safety Plan becomes the foundation for the Rocky Flats Plant IGMP/CSPCP Health and Safety Plan and is incorporated, as appropriate, by reference.

2. POLICY AND STANDARDS

It is DOE's policy that its operations shall be conducted in a manner that will (1) limit risks to the health and safety of the public and employees, and (2) adequately protect property and the environment. As outlined in the CGMP Health and Safety Plan, DOE has responsibility for health, safety, and environmental protection programs at DOE-owned contractor-operated facilities. Consistent with this responsibility, this Health and Safety Plan includes the current health and safety policy and standards in effect at Rocky Flats Plant. It also includes provisions to implement external subcontractor policy and standards when the latter are determined to be more restrictive.

2.1. POLICY

The main tenet of this IGMP/CSPCP Health and Safety Plan is to keep human exposure to toxic materials and radiation at levels as low as reasonably achievable (ALARA). The ALARA review will demonstrate that all reasonable efforts have been made to minimize worker and public exposures to toxic and/or radioactive materials.

Specific ALARA procedures will include engineering controls, administrative controls, and the use of personal protective equipment. The length of time employees spend in areas with elevated levels of radioactive or toxic materials will be minimized. If conditions produce airborne contaminants, dust suppressant measures will be taken. General requirements for limiting exposures, and protective clothing and equipment necessary to protect personnel from contaminants are identified in the CGMP Health and Safety Plan and are specifically addressed in this IGMP/CSPCP Health and Safety Plan, Section 4.2.

2.2 STANDARDS AND REGULATIONS

The environmental, safety, and health protection requirements applicable to Rocky Flats Plant operations are set forth in DOE and DOE-Albuquerque Operations Office Orders. These orders require compliance with applicable Federal, State of Colorado, or local standards. This Rocky Flats Plant IGMP/CSPCP Health and Safety

Plan is based on these DOE Orders, Federal regulations, and other professional standards specified in Section 2 of the CGMP Health and Safety Plan

2.3. PERMITS

Permits issued by Rocky Flats will be obtained as required for all land use activities (e.g., drilling, boring, samples, and entry), following the current health and safety policy and standards in effect at Rocky Flats Plant

3. HEALTH AND SAFETY RESPONSIBILITIES

The line organizations conducting CEARP Phase 2b Site Characterizations (Remedial Investigations) are responsible for providing adequate precautions and protection to ensure the health and safety of employees and the public. The simplified organizational chart for health and safety at Rocky Flats Plant is presented in Figure 3.1

3.1 GENERAL RESPONSIBILITIES

For site characterization (remedial investigation) activities conducted at Rocky Flats Plant, the Rockwell International CEARP Manager establishes requirements following guidelines specified in this IGMP/CSPCP Health and Safety Plan that are consistent with current health and safety requirements. The Subcontractor Site Manager is responsible for ensuring the health and safety of field team personnel during CEARP Phase 2b site characterization (remedial investigation) activities. The Subcontractor Site Health and Safety Coordinator provides guidance to the Subcontractor Site Manager regarding potential health hazards during characterization activities. The Subcontractor Site Health and Safety Coordinator has the authority to terminate field activities at specific sites if unsafe conditions develop.

3.2 INSTALLATION REQUIREMENTS

Primary health and safety responsibility at Rocky Flats Plant rests with Rockwell International Health, Safety and Environment Department Director. Representatives of the Rockwell International Health, Safety, and Environment Department, under direction of the Rockwell International CEARP Manager, will review and concur with the SSMP Health and Safety Plans prior to commencement of site characterizations (remedial investigations). The Rockwell International Health, Safety, and Environment Department will also provide guidance to the Subcontractor Project Manager for establishing health and safety requirements.

3.3. SPECIFIC RESPONSIBILITIES

Specific responsibilities assigned to the functional health and safety organization for the Rocky Flats Plant CEARP Phase 2b site characterizations (remedial investigations) are provided in the following sections

3.3.1. Los Alamos National Laboratory

Because the site characterizations (remedial investigations) will be conducted by Rockwell International, Los Alamos National Laboratory does not have responsibility for implementing Health and Safety Plans.

3.3.2. Rockwell International CEARP Manager

The Rockwell International CEARP Manager shall

- ensure that the Rocky Flats Plant SSMP Health and Safety Plans are prepared, reviewed, and concurred with by the appropriate individuals within DOE-Albuquerque Operations Office and Rocky Flats Plant,
- concur in the selection of the Subcontractor Site Manager and Subcontractor Site Health and Safety Coordinator,
- ensure that personnel involved with CEARP Phase 2b site characterizations (remedial investigations) comply with the IGMP/CSPCP Health and Safety Plans,
- require periodic health and safety audits (at least once during each stage of sampling), review Health and Safety Audit Reports, and require responses to Health and Safety Audit Report findings and recommendations,
- act on employee concerns in accordance with the procedures outlined in DOE Orders and take appropriate action to correct violations,
- review and evaluate requests for variance from the Health and Safety plans, and
- ensure that the proper reports required by DOE and DOE-Albuquerque Operations Office orders are submitted, including accident investigation reports, as necessary

3.3.3. Subcontractor Project Manager

The Subcontractor Project Manager shall

- assign a Subcontractor Site Manager (Section 3.3.4) who will be responsible for ensuring the health and safety of field team personnel during CEARP Phase 2b Site Characterization (Remedial Investigation) activities,
- assign a Subcontractor Site Health and Safety Coordinator (Section 3.3.5) to ensure implementation of the Rocky Flats Plant IGMP/CSPCP Health and Safety Plan and each SSMP Health and Safety Plan, and
- read, concur, and comply with the Rocky Flats Plant IGMP/CSPCP Health and Safety Plan.

3.3.4 Subcontractor Site Manager

The Subcontractor Site Manager shall

- submit requests for variance from the requirements of this plan to the Subcontractor Project Manager and Rockwell International CEARP Manager, when appropriate,
- assure that requirements specified in DOE and DOE-Albuquerque Operations Office Orders 5484.1 are recorded and reported for all employees,
- ensure that personnel involved with CEARP Phase 2b site characterizations (remedial investigations) comply with the IGMP/CSPCP Health and Safety Plans,
- monitor the performance of employees involved in site characterization (remedial investigation) activities to ensure compliance with health and safety requirements,
- be familiar with emergency response procedures and notification requirements, and implement them accordingly, and
- terminate work activities if unsafe conditions develop or when directed to do so by the Subcontractor Site Health and Safety Coordinator

3.3.5. Subcontractor Site Health and Safety Coordinator

A Subcontractor Site Health and Safety Coordinator will be designated by the Subcontractor Project Manager for each stage of the Phase 2b site characterization

(remedial investigation) activities The Rockwell International CEARP Manager shall concur in the selection of the Subcontractor Site Health and Safety Coordinator The Subcontractor Site Health and Safety Coordinator is responsible for conducting a review of the proposed activities prior to commencement of operations, evaluating potential hazards, and recording the appropriate information on a Work Location, Personnel Protection, and Safety Evaluation Form (Appendix A) Activities that require special monitoring or certain personal protective equipment will be specified in the SSMP Health and Safety Plans In addition to the duties outlined in Section 3.4 of the CGMP Health and Safety Plan, specific responsibilities of the Subcontractor Site Health and Safety Coordinator include the following

- being present or having an acceptable alternate present when subcontractor work activities are being performed in areas requiring decontamination of personnel or equipment,
- advising the Rockwell International CEARP Manager, and the Subcontractor Site Manager of potential health and safety hazards during site characterization (remedial investigation) activities;
- conduct special monitoring, if necessary,
- evaluate potential modifications to work plans and personal protective equipment requirements to ensure employee safety,
- ensure that site characterization (remedial investigation) team members have been trained in the appropriate safety procedures for the activities they will conduct, have current medical certification that they are physically fit to perform required tasks, and have participated in all required dosimetry or bioassay training programs;
- contact the appropriate local emergency organizations (police, fire, ambulance, and hospital) to coordinate emergency response activities,
- require that the Subcontractor Field Team Leader terminate work activities if unsafe conditions develop, or an imminent hazard is perceived,
- prepare variances from the health and safety requirements if needed, and
- carry out health and safety audits and prepare health and safety audit reports as required by this IGMP/CSPCP Health and Safety Plan

3.4. AUDITS

Health and safety audits will be conducted by the Subcontractor to ensure adequate implementation of the requirements of this IGMP/CSPCP Health and Safety Plan. Audits will be conducted by the Subcontractor Site Health and Safety Coordinator and documented in Health and Safety Audit Reports to be issued by the Subcontractor Project Manager. The Los Alamos National Laboratory CEARP Team Leader and the Rockwell International CEARP Manager will receive copies of these reports. Individuals responsible for health and safety deficiencies noted in the audit findings will provide written responses describing corrective actions that have been implemented to resolve the findings.

The Rockwell International Health, Safety, and Environment Department may also conduct health and safety audits, separately or concurrently, with subcontractor audits.

3.5. VARIANCES FROM HEALTH AND SAFETY REQUIREMENTS

Where special conditions exist, a written request for a variance from a specific health and safety requirement may be submitted by the Subcontractor Site Health and Safety Coordinator to the Subcontractor Project Manager. If the Subcontractor Project Manager agrees with the request, the request will be reviewed by the Rockwell International CEARP Manager and representatives of the Rockwell International Health, Safety, and Environment Department. The conditions of the request will be evaluated and, if appropriate, a variance specifying the conditions under which the requirement may be modified will be granted in writing. A copy of the variance will be retained in the field during work activities in which it is invoked.

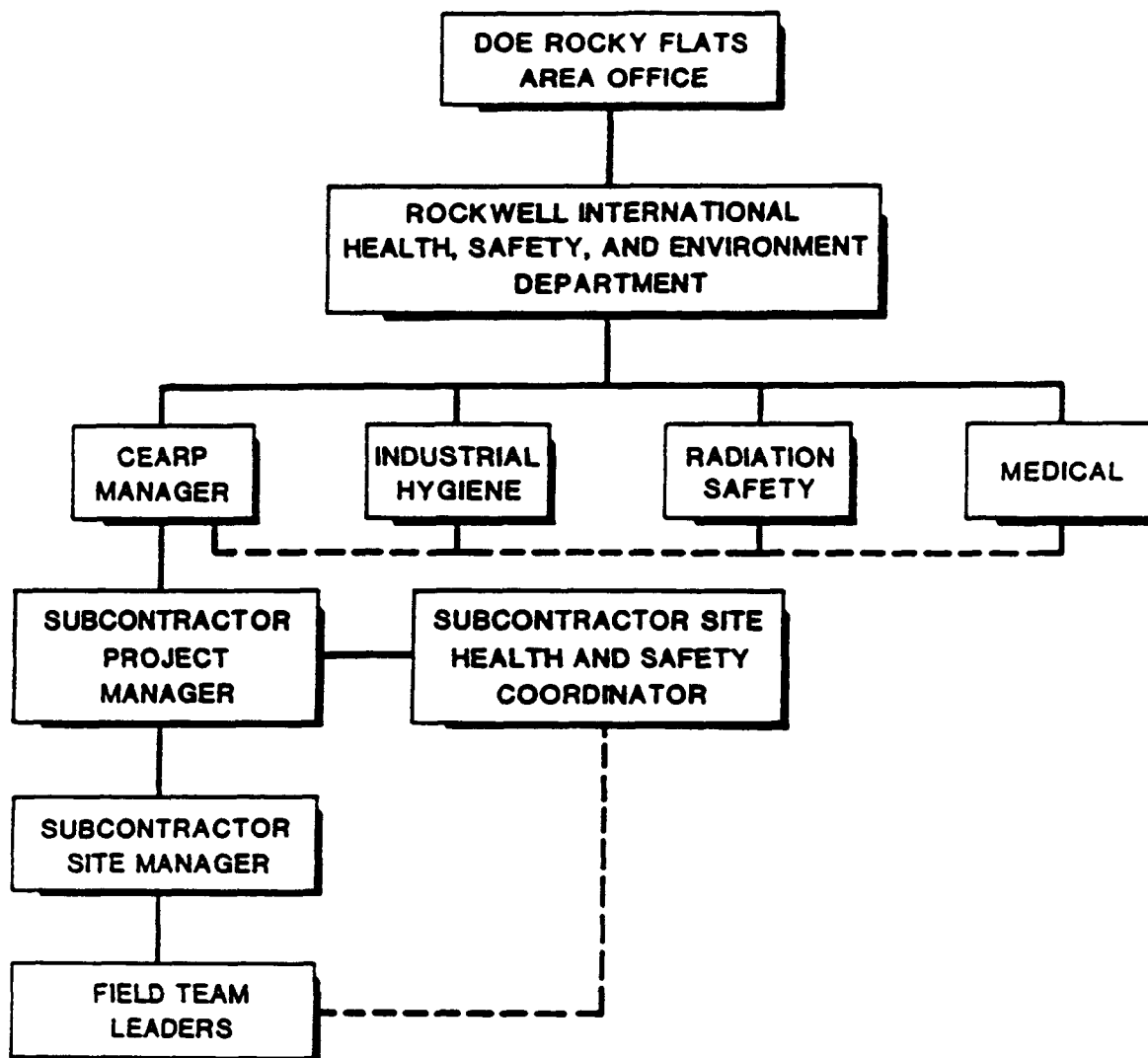


Figure 3 1 Simplified Health and Safety Organizational Chart for Rocky Flats Plant

4. HAZARD ASSESSMENT AND PERSONNEL PROTECTION REQUIREMENTS

The following section provides a description of anticipated potential hazards anticipated at Rocky Flats Plant. The hazards description includes physical, chemical, radiological and biological hazards, followed by general requirements for limiting exposures, monitoring contaminant concentrations, and measuring employee exposure.

4.1. IDENTIFICATION OF POTENTIAL HAZARDS

4.1.1. Physical Hazards

The following physical hazards are anticipated at Rocky Flats Plant:

Heat Stress

The body's physiological processes fail to maintain a normal body temperature because of excessive heat. A number of physical reactions can occur, ranging from mild to fatal.

Heat-Related Problems

- Heat Rash, caused by continuous exposure to heat and humid air aggravated by chafing clothes. Decreases ability to tolerate heat and becomes a nuisance.
- Heat Cramps, caused by profuse perspiration with inadequate fluid intake and chemical replacements (especially salts). Signs: muscle spasm and pain in the extremities and abdomen.
- Heat exhaustion, caused by increased stress on various organs to meet increased demands to cool the body. Signs: shallow breathing, pale, cool, moist skin, profuse sweating, dizziness and lassitude.
- Heat stroke, the most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs: red, hot, dry skin, no perspiration, nausea, dizziness and confusion, strong rapid pulse, coma.

Work/Rest Schedule

When working in level B or C protective clothing, the following guideline for calculating the work/rest schedule shall be used.

Calculate the adjusted temperature.

$$T(\text{adjusted}) = T(\text{actual}) + (13 \times \text{sunshine fraction})$$

100% sunshine =	no cloud cover	= 1.0
50% sunshine =	50% cloud cover	= 0.5
0% sunshine =	full cloud cover	= 0.0

Adjusted Temperature

Active Work Time (min/hr)

75 or less	50
80	40
85	30
90	20
95	10
100	0

Cold Exposure

Persons working outdoors in temperatures at or below freezing can become frostbitten. Exposure to extreme cold for short time periods can cause severe injury to the body surface or can result in profound generalized cooling, causing death. Body areas which have high surface-area-to-volume ratios (e.g., fingers, toes, and ears) are the most susceptible.

Cold Exposure-Related Problems

- Frost nip or incipient frostbite, characterized by sudden blanching or whitening of skin
- Superficial frost bite, which causes skin to become waxy or white and superficially firm, but resilient beneath
- Deep frostbite, characterized by cold, pale, solid skin tissues
- Systemic hypothermia, caused by exposure to freezing or rapidly dropping temperature. Symptoms are usually exhibited in five stages: 1) shivering, 2) apathy, listlessness, sleepiness and (sometimes) rapid cooling of the body to less than 95°F, 3) unconsciousness, glassy stare, slow pulse and slow respiratory rate, 4) freezing of the extremities, and finally, 5) death.

Caution will be used to prevent cold exposure by wearing properly insulated garments beneath protective clothing and by taking frequent warm-up breaks.

Noise

When noise exceeds acceptable levels (limits specified in Department of Air Force Regulation 161-35 TLV's) administrative or engineering controls designed to reduce exposures will be utilized. If these controls are not sufficient, approved ear protection will be provided and its use mandated. Noise levels will be monitored when it becomes necessary to speak loudly under normal working conditions.

Standard Precautions for Equipment and Structures

Site characterizations (remedial investigations) at Rocky Flats Plant may require the use of shovels, drill rigs, portable augers, and backhoes. Prior to any surface disturbance the required permit will be obtained from Rocky Flats Plant. Heavy equipment will be operated according to OSHA recommendations and requirements.

- Only qualified and licensed personnel shall be allowed to operate this equipment
- Heavy equipment shall be operated and maintained in conformance with established standards and inspected prior to use, as directed by Federal, State or OSHA regulations.
- Overhead electrical power lines shall be considered energized unless Rocky Flats Plant Utilities Manager has verified de-energization
- While in use, drilling rigs shall maintain the following minimum distances from overhead power lines: 10 ft for 50 kv, 20 ft for 345 kv, and 34 ft for 750 kv

In transit, with the boom or derrick lowered, the closest approach to a powerline shall be 4 ft for 50 kv, 10 ft for 50-345 kv, and 16 ft for 345-750 kv

Flammable and/or Combustible Materials

Several sites requiring characterization could contain flammable or combustible materials. The SSMP Health and Safety Plans will contain detailed information on the likelihood of encountering combustible materials and specific health and safety requirements for these areas.

4.1.2 Known Chemical Hazards

Known chemical hazards at Rocky Flats Plant include possible inhalation, ingestion, or dermal absorption of organic compounds, solvents, or other toxic materials. Specific properties of known chemical contaminants are provided in Appendix A. If it is determined that additional chemicals are present at Rocky Flats Plant, Appendix A will be amended. Levels or concentrations of these hazardous materials can be estimated from groundwater sampling results.

4.1.3. Known Radiological Hazards

Radionuclides are expected to be present at Rocky Flats Plant. The specific properties of the known radionuclides, including type of emission, half-life, maximum allowable concentrations, and body burdens are provided in Appendix A. The specific properties of the known radionuclides including type of emission, half-life, maximum allowable concentrations, and body burdens are provided in Appendix A.

There are three principal pathways by which individuals could be exposed to radioactivity during site characterizations (remedial investigations). These are (1) inhalation or ingestion, (2) dermal absorption, and (3) exposure to direct radiation from contaminated materials (see 4.2. for personnel protection requirements).

4.1.4 Biological Hazards

Certain biological hazards are anticipated at Rocky Flats Plant:

- insects, including ticks and mosquitoes,
- snakes of poisonous and nonpoisonous species, and
- rodents, including mice and rats

If a worker is bitten by a rodent or snake, the Subcontractor Site Health and Safety Coordinator will be immediately notified. The Rocky Flats Plant installation medical center shall be contacted and appropriate medical care given.

4.2. PERSONNEL PROTECTION REQUIREMENTS

4 2.1 Protection Levels and Protective Clothing

As stated in the CGMP Health and Safety Plan, the U.S. Environmental Protection Agency (EPA) has established four levels of protection for personnel entering potentially hazardous sites. The work at Rocky Flats Plant is anticipated to be conducted in levels B, C, and D protection based upon known hazards. The SSMP Health and Safety Plan will define zones of contamination and identify which levels of protection will be required for each zone. All personnel entering a zone will be required to wear the attire designated for that zone.

4 2.2. Protective Equipment

As stated in the CGMP Health and Safety Plan, a variety of safety equipment will be used to protect personnel from safety hazards and minimize exposures to hazardous chemicals and radionuclides during Rocky Flats Plant site characterizations (remedial investigations). Portable monitors and meters will be used to determine exposures and measure air concentrations of radiological and chemical contaminants. The safety equipment used will include photoionization and organic vapor analyzers, air samplers, radiation survey meters, explosive gas concentration meters, detector tubes, and thermoluminescent dosimeters. This safety equipment is fully described in the CGMP Health and Safety Plan. The SSMP Health and Safety Plans will outline specific equipment to be used, and action levels to be taken for each type of measurement.

Cooling vests and warming equipment will be available to minimize stress from climatic conditions. As outlined in the CGMP Health and Safety Plan, emergency equipment including fire extinguishers, first aid kits, blankets, and eye wash kits will be available for emergency treatment.

4 2.3 General Safety Practices and Mitigation Measures

As stated in the CGMP Health and Safety Plan, some hazards can be minimized through the implementation of specific procedures, use of special equipment, training of personnel, or availability of emergency response equipment in the event of

an accident. The general requirements listed in the CGMP Health and Safety Plan will be observed during all Rocky Flats Plant site characterizations (remedial investigations)

Work that may involve resuspension of contaminants into the air will be suspended when the wind speed exceeds 15 miles per hour

Morning meetings for all personnel involved in sampling will be held daily. These meetings will be used to express health and safety concerns related to the day's activities. Standard safe working practices, described in Section 4 of the CGMP Health and Safety Plan, will be followed. Appendix A provides a list of potential chemical and hazards radiological and their respective method of detection and Threshold Limit Value (TLV). A detailed description of hazards and hazardous materials which could be encountered at each site will be provided in each SSMP Health and Safety Plan. The SSMP Health and Safety Plans will also provide site-specific safety practices and mitigative measures.

4.3. SITE ACCESS CONTROL

4.3.1 Restricted Access Zones

As stated in the CGMP Health and Safety Plan, control zones will be established prior to commencement of work at contaminated sites to protect employees and the general public from unnecessary exposure to toxic materials and/or radiation, and to prevent inadvertent spread of contamination. The control (exclusion) zones will be designated in each SSMP Health and Safety Plan based on the nature, magnitude, and extent of contamination, and the potential for contaminant migration. Decontamination is required for personnel, equipment, and vehicles moving from an exclusion zone to a clean zone.

The decontamination of equipment and personnel will be conducted in steps starting at exclusion zones, proceeding through contamination reduction zones, and ending at clean zones. The size and number of contamination reduction zones will be determined on a site-specific basis and will be provided in each SSMP Health and Safety Plan. Exclusion criteria, protection requirements, contact person, and other relevant information will be posted at the access station of each exclusion zone.

4.3.2. Decontamination

At Rocky Flats Plant, decontamination will follow the general procedures described in Section 4 of the CGMP Health and Safety Plan. Each SSMP Health and Safety Plan will clearly define decontamination procedures for specific contaminants of concern

Decontamination solutions used will be selected according to contaminants encountered on a site-specific basis. Radionuclides anticipated at Rocky Flats Plant can be removed from personnel and equipment using dilute soap and water solutions. Organic compounds and solvents will require use of slightly stronger detergents for effective removal. Following decontamination, verification measurements will be made to ensure that contaminants have been removed to safe levels. For articles or personnel contaminated by low energy beta emitters, swipe-samples will be collected and analyzed using liquid scintillation detectors. For alpha and high energy beta emitters, a survey meter will be used to evaluate decontamination. Following this "frisking," swipes will be collected and analyzed using a gross alpha/beta counting meter.

4.4. WORKER TRAINING

As described in the CGMP Health and Safety Plan, health and safety training will be conducted and documented for all members of site characterization (remedial investigation) field teams. The level of training for each team will be commensurate with job functions and potential hazards in work areas and comply with the RCRA part B Operating Permit Application, Section H. This will be in addition to completion of any subcontractor basic health and safety training, or the equivalent, that must be approved prior to site assignment. At least two field members of each field team will be required to have current certification in American Red Cross Multi-Media First Aid and Cardio Pulmonary Resuscitation (or the equivalent). In addition, training for all field team members will meet right-to-know requirements and will follow the outline in Appendix A, which includes

- radiological safety,
- hazard identification and recognition,
- potential health effects and symptoms of exposure,
- protective equipment requirements and proper use,
- decontamination procedures,

- controlled area restrictions, and
- emergency response requirements

4.5. EMPLOYEE MEDICAL PROGRAM

As stated in the CGMP Health and Safety Plan, site characterization (remedial investigation), subcontractor field team members shall participate in an employee medical examination program. Their suitability for conducting field sampling activities (including possible respirator use) will be evaluated and documented by a physician. Medical programs must comply with requirements of DOE Order 5480 1A Chapter VIII.

4.6. RECORDS AND REPORTING REQUIREMENTS

Subcontractors will maintain health and safety records and submit reports, as required by DOE Orders, to the Subcontractor CEARP Project Manager. These will include the following:

- DOE Form 5484.3 Supplementary Record of Occupational Injuries and Illnesses
- DOE Form 5484.4 Tabulation of Property Damage Experience
- DOE Form 5485.5 Report of Property Damage or Loss
- DOE Form 5484.6 Annual Summary of Whole Body Exposures to Ionizing Radiation
- DOE Form 5484.7 Summary of Exposures Resulting in Internal Body Depositions of Radioactive Materials for CY
- DOE Form 5484.8 Termination Occupational Exposure Report
- DOE Form OSHA-200 Log of Occupational Injuries and Illness
- DOE Form EV-102A Summary of Department of Energy and Department of Energy Contractor Occupational Injuries and Illnesses
- DOE Form 5821.1 Unplanned Releases Form

The Subcontractor Project Manager will distribute copies of the reports to Los Alamos National Laboratory, the DOE-Albuquerque Operations Office, and the

Rockwell International Health and Safety Department, as appropriate. Specific reporting responsibilities are given in the following subsection.

4.6.1 Exposure and Medical Records

Subcontractors will maintain confidential medical records for each field team member as indicated by the employee medical program. These records will identify individuals by name, date of birth, social security number, and additional identifiers as desired by the subcontractor. The employee's accident record and history of exposures and/or possible exposures to hazardous physical, chemical, or biological agents will be included with the medical records.

The Subcontractor Site Health and Safety Coordinator will prepare, and submit to the Subcontractor Project Manager and the Rockwell International CEARP Manager, radiation exposure reports as required in DOE Order 5484.1. Form 5484.8, "Termination Occupational Exposure Report," will be completed for any employee included in a radiation monitoring program upon termination of employment. Forms 5484.7, "Summary of Exposures Resulting in Internal Body Depositions of Radioactive Materials for CY 19XX," and 5484.6, "Annual Summary of Whole Body Exposures to Ionizing Radiation," will be submitted annually by March 31 for monitored employees. These reporting requirements are currently under revision by DOE, and the Subcontractor Site Health and Safety Coordinator shall comply with the new requirements when they become final.

4.6.2 Accident/Incident Reports

The Subcontractor Site Health and Safety Coordinator will notify the Subcontractor Project Manager and the Rockwell International CEARP Manager of any accidents or incidents that occur during site characterizations (remedial investigations) at Rocky Flats Plant. The Subcontractor Site Health and Safety Coordinator will also submit a completed DOE Form F 5484.X for any of the following incidents:

- (1) "Recordable" occupational injuries or illnesses are defined below:

OCCUPATIONAL INJURY is any injury such as a cut, fracture, sprain, or amputation that results from a work accident or from an exposure involving a single incident in the work environment.

NOTE Conditions resulting from animal or insect bites, or one-time exposure to chemicals, are considered to be injuries

OCCUPATIONAL ILLNESS of an employee is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases which may be caused by inhalation, absorption, ingestion, or direct contact with a toxic material

- (2) **PROPERTY DAMAGE LOSSES** of \$1,000 or more are reported as follows accidents which cause damage to DOE property, regardless of fault, or accidents wherein DOE may be liable for damage to a second party, are reportable if damage is \$1,000 or more Include damage to facilities, inventories, equipment, and properly parked motor vehicles Exclude damage resulting from a DOE reportable vehicle accident
- (3) **GOVERNMENT MOTOR VEHICLE ACCIDENTS** resulting in damages of \$250 or more, or involving an injury, are reported unless the Government vehicle is not at fault, damage of less than \$250 is sustained by the Government vehicle, and no injury is inflicted on the Government vehicle occupants Accidents are also reportable to DOE if
 - damage to a Government vehicle, not properly parked, is greater than or equal to \$250;
 - damage to DOE property is greater than or equal to \$250 and the driver of a Government vehicle is at fault,
 - damage to any private property or vehicle is greater than or equal to \$250 and the driver of a Government vehicle is at fault, and
 - any person is injured and the driver of a Government vehicle is at fault

4.7 EMPLOYEE INFORMATION

The Subcontractor Site Health and Safety Coordinator shall ensure that the following DOE forms are posted where field team members can easily read them

- Form F 5480.2 Occupational Safety and Health Protection,
- Form F 5480.4 Occupational Safety and Health Complaint Form

Also, the Rocky Flats Plant Health and Safety Standard concerning employee right-to-know shall be provided in each SSMP and appropriately posted.

5. EMERGENCY RESPONSE AND NOTIFICATION

This section provides guidelines for responses to emergency situations

5.1. EMERGENCY CONTACTS

Names of persons to contact in case of emergencies will be provided in the format found in Figure 5.1. This emergency contact form will be copied and posted in prominent locations at the work sites. Additional contacts are given in the Safety Evaluation Form (Appendix A).

5.2. CONTINGENCY PLANS

Field team leaders, with assistance from the Subcontractor Site Health and Safety Coordinator, shall have responsibility and authority for coordinating all emergency response activities until proper authorities arrive and assume control. A copy of these plans shall be available at the work site at all times, and all personnel working on the site shall be familiar with the plans. Evacuation plans and routes shall be on a job-specific basis, and all personnel shall be familiar with them.

5.2.1. Fire/Explosion

Any fire emergency will be handled by immediately notifying the fire department. Only if the fire appears to be small and easily extinguishable will personnel attempt control with fire extinguishers available in the work area. Otherwise, immediate evacuation of the area is indicated.

If combustible gas/oxygen meters show explosive gas or oxygen concentrations approaching 25% of the lower explosive limits, all personnel will be evacuated and the fire department will be notified. In the event of an explosion, all personnel shall be evacuated and no one shall re-enter the area until it has been cleared by explosives safety personnel.

5.2.2. Personnel Injuries

In case of injuries to personnel, first aid treatment will be initiated immediately by trained personnel. In case of serious injuries, the victim will be transported to the Rocky Flats Plant medical center as soon as possible. Minor injuries may be treated onsite, but all injuries will be examined by trained medical personnel. Victims of serious bites or stings will be taken to the Rocky Flats Plant medical center. In the event that an injured person is contaminated with chemicals or radionuclides, the person shall be taken as soon as possible to the Rocky Flats Plant medical center. Decontamination shall be performed to prevent further exposure only if it will not aggravate the injury. Treatment of life threatening or serious injuries will always be considered first.

5.2.3. Accidental Releases of Radionuclides to the Environment

In case of releases of radionuclides to the environment (such as a spill of samples being transported for analysis), emergency response shall be in accordance with Rocky Flats Plant procedures. The Subcontractor Site Manager or Field Team Leader shall notify the Rockwell International CEARP Manager of such an event.

5.3. NOTIFICATION REQUIREMENTS

Reporting and notification of emergency situations shall be carried out in accordance with requirements in DOE Order 5484.1. The Field Team Leader shall notify the Subcontractor Site Manager. The Subcontractor Site Manager will notify appropriate emergency assistance personnel (e.g., fire, police, ambulance at ext. 2911), and the Rockwell International CEARP Manager. The responsibility of the Subcontractor Site Health and Safety Coordinator for Rocky Flats Plant is to implement notification and reporting requirements of DOE Order 5484.1.

Site Health and Safety Coordinator--

Name:

Call: _____

Installation Health and Safety Officer--

Name: _____ Call: _____

24-Hour Installation Health/Safety Coordinator--

Call: _____

FIRE-- Call: _____

AMBULANCE-- Call: _____

POISON CENTER-- _____

SECURITY-- Call: _____

POLICE-- Call: _____

YOU ARE LOCATED AT: _____

THE NEAREST TELEPHONE IS LOCATED AT:

THE NEAREST EMERGENCY MEDICAL SERVICES ARE LOCATED AT:

Figure 51 Emergency Contacts

6. ENVIRONMENTAL MONITORING

Environmental impacts from CEARP site characterizations (remedial investigations) are expected to be negligible. Additional sampling to supplement Rocky Flats Plant routine monitoring activities is not considered necessary. Monitoring of air quality for personnel protection will provide data to re-evaluate the need for environmental monitoring. Additional guidance and detail regarding monitoring during site characterizations (remedial investigations) will be provided in SSMP Sampling Plans.



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**DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATIONS OFFICE
ENVIRONMENT, SAFETY AND HEALTH DIVISION
ENVIRONMENTAL PROGRAMS BRANCH**

**COMPREHENSIVE ENVIRONMENTAL ASSESSMENT
AND RESPONSE PROGRAM**

**PHASE 2:
ROCKY FLATS PLANT
SITE-SPECIFIC MONITORING PLAN
(Work Plan for Performance of Remedial Investigations and
Feasibility Studies for all High Priority Sites)**

HEALTH AND SAFETY PLAN

February 1987

DRAFT

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1. INTRODUCTION

CEARP Phase 2 Confirmation consists of CEARP Phase 2a, Monitoring Plan, and CEARP Phase 2b Site Characterizations (Remedial Investigations) This Health and Safety Plan is one component of the Monitoring Plan for Rocky Flats Plant The Monitoring Plan typically consists of five parts Synopsis, Sampling Plan, Technical Data Management Plan, Health and Safety Plan, and Quality Assurance/Quality Control Plan Because of the Compliance Agreement by the State of Colorado, the Environmental Protection Agency, and the DOE, this Monitoring Plan also includes a Feasibility Study Plan The Synopsis provides a discussion of the current situation and serves as an introduction to the other plans

CEARP uses a three-tiered approach in the preparation of monitoring plans the CEARP Generic Monitoring Plan (CGMP), the Installation Generic Monitoring Plan (IGMP), and the Site-Specific Monitoring Plans (SSMPs)

This SSMP is the Work Plan for Performance of Remedial Investigations and Feasibility Studies for all High Priority Sites required by the Compliance Agreement Therefore, the acronym used to refer to this plan is SSMP/RIFS

Consistent with the tiered approach being used by CEARP, this SSMP/RIFS Health and Safety Plan incorporates the specific safety practices and procedural review requirements for Rocky Flats Plant as outlined in the IGMP/CSPCP Health and Safety Plan, and the general requirements of DOE as specified in the CGMP Health and Safety Plan Therefore, this Health and Safety Plan has been written at a site-specific level, and includes justifications for personnel protection requirements proposed at each site (Section 4)

2. POLICY AND STANDARDS

It is DOE's policy that its operations shall be conducted in a manner that will (1) limit risks to the health and safety of the public and employees, and (2) adequately protect property and the environment. As outlined in the CGMP Health and Safety Plan, DOE has responsibility for health, safety, and environmental protection programs at DOE-owned contractor-operated facilities. Consistent with this responsibility, this Health and Safety Plan includes the current health and safety policy and standards in effect at Rocky Flats Plant. It also includes provisions to implement external subcontractor policy and standards when the latter are determined to be more restrictive.

2.1. POLICY

The main tenet of this SSMP/RIFS Health and Safety plan is to keep human exposure to toxic materials and radiation at levels as low as reasonably achievable (ALARA). Specific ALARA procedures will include engineering controls, administrative controls, and the use of personal protective equipment. The length of time employees spend in areas with elevated levels of radioactive or toxic materials will be minimized. If conditions produce airborne contaminants, dust suppressant measures will be taken.

2.2 STANDARDS AND REGULATIONS

The environmental, safety, and health protection requirements applicable to Rocky Flats Plant operations are set forth in DOE and DOE-Albuquerque Operations Office Orders. These orders require compliance with applicable federal, State of Colorado, or local standards. This Rocky Flats Plant SSMP/RIFS Health and Safety Plan is based on these DOE Orders, federal regulations, and other professional standards specified in the CGMP and IGMP/CSPCP Health and Safety Plans.

3. HEALTH AND SAFETY RESPONSIBILITIES

The line organizations conducting CEARP Phase 2b site characterizations (remedial investigations) are responsible for health and safety of employees and the public. The simplified organizational chart for health and safety at Rocky Flats Plant is presented in Figure 3.1.

3.1. GENERAL RESPONSIBILITIES

General responsibilities for health and safety are defined in the Rocky Flats Plant IGMP/CSPCP Health and Safety Plan. In brief, the Subcontractor Site Manager is responsible for ensuring the health and safety of field team personnel. The Subcontractor Site Health and Safety Coordinator provides guidance to the Subcontractor Site Manager regarding potential health hazards during characterization activities. The Subcontractor Site Health and Safety Coordinator has the authority to terminate field activities at specific sites if unsafe conditions develop.

3.2. INSTALLATION RESPONSIBILITIES

Installation health and safety responsibilities are stated in the Rocky Flats Plant IGMP/CSPCP. In brief, the Rockwell International Health, Safety and Environment Department Director has primary responsibility for implementing health and safety requirements at Rocky Flats Plant. Representatives of the Rockwell International Health, Safety, and Environment Department, under direction of the Rockwell International CEARP Manager, will provide guidance to the Subcontractor Project Manager for establishing health and safety requirements in conjunction with the current health and safety policy and standards in effect at Rocky Flats Plant.

3.3. SPECIFIC RESPONSIBILITIES

Responsibilities assigned to the functional health and safety organization for the Rocky Flats Plant are provided in the IGMP/CSPCP Health and Safety Plan.

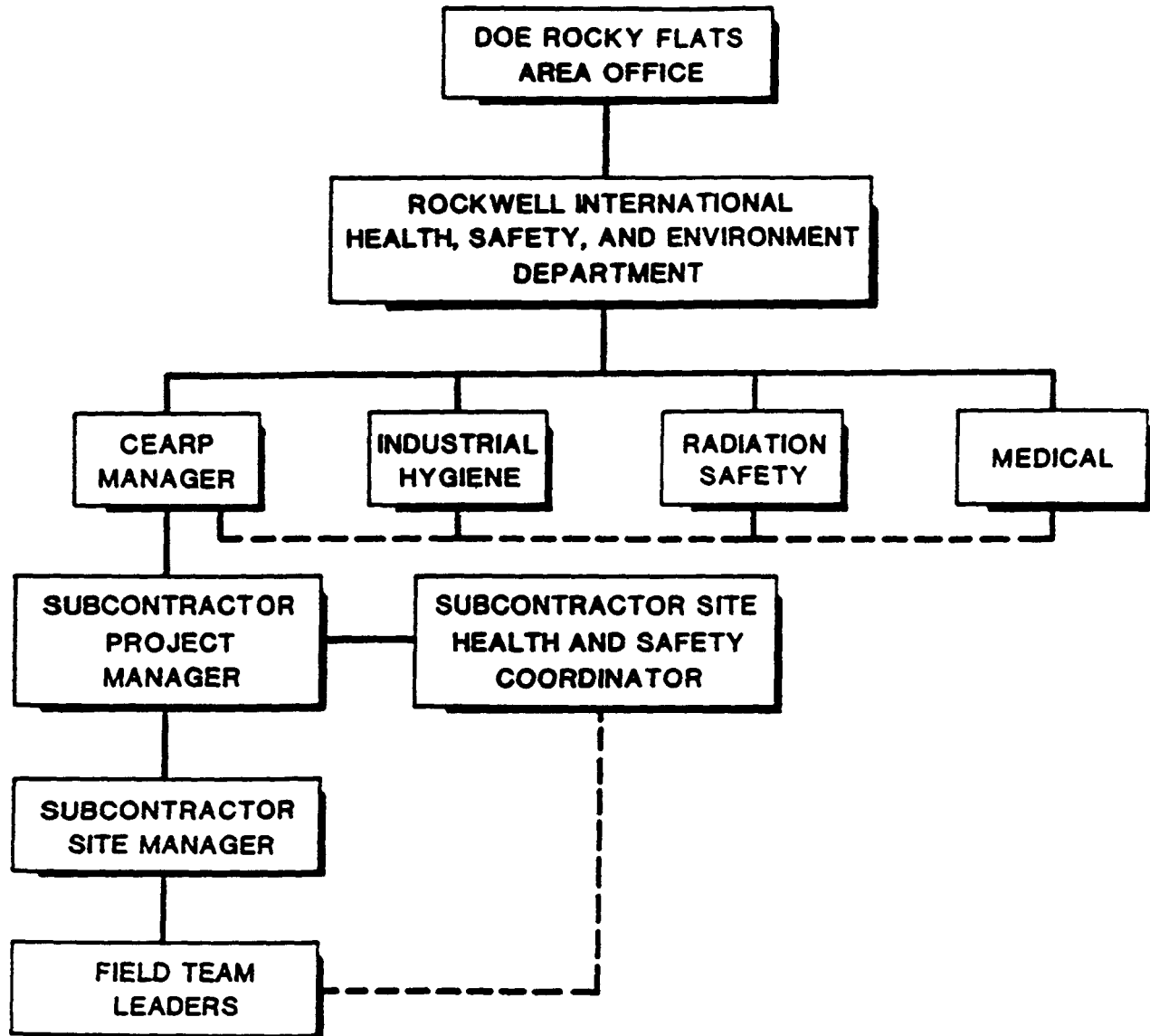


Figure 3 1 Simplified Health and Safety Organizational Chart for Rocky Flats Plant

4. HAZARD ASSESSMENT AND PERSONNEL PROTECTION REQUIREMENTS

The following section provides a description of anticipated site-specific hazards at Rocky Flats Plant. The installation-wide potential hazards are described in the IGMP/CSPCP Health and Safety Plan.

4.1. IDENTIFICATION OF POTENTIAL HAZARDS

Specific chemical and radiological contaminants at the high-priority sites are discussed in the following sections and are presented in Appendix A. These site-specific discussions are based on data presented in the Rocky Flats Plant RCRA Part B Operating Permit Application (DOE 1986f). If additional hazards are found during CEARP Phase 2b site characterizations (remedial investigations), this health and safety plan will be amended as appropriate.

4.1.1. 881 Hillside Site

The principal chemical contaminants of concern in the vicinity of the 881 Hillside Site are chlorinated hydrocarbons (tetrachloroethylene, trichloroethylene, 1,1,1-trichloroethane and 1,1-dichloroethylene) (DOE 1986f). The highest measured concentrations of these compounds in groundwater were detected during 1986 in well 9-74. These highest measured values were 4800 (ppb) of tetrachloroethylene, 11 000 ppb of trichloroethylene, 14 000 ppb of 1,1,1-trichloroethane and 7200 ppb of 1,1-dichloroethylene. Lower concentrations of these compounds were detected in previous sampling events (DOE 1986f). There were no deflections of the photoionization detector noted during the recent well installations on the 881 Hillside Site.

4.1.2 903 Pad Area Site

The potential exists to encounter chlorinated hydrocarbons at the 903 Pad Area Site during site characterization (remedial investigation) activities. The 903 drum storage area (SWMU 112) was utilized as a storage facility for drums containing radioactive contaminated lathe coolant. The lathe coolant consisted of approximately

chloroethylene, 260 ppb of trichloroethylene, 53 ppb of t,1,2-dichloroethylene, 159 ppb of chloroform, and 1560 ppb of carbon tetrachloride (DOE 1986f) Wells 41-86 and 7-74 are located east of trenches T-4 to T-11 (SWMU 111) Well 41-86 did not contain chlorinated hydrocarbons above detection limits, but at well 7-74 trichloroethylene and tetrachloroethylene were both detected at concentrations of 16 ppb (DOE 1986f)

The east trenches contain known uranium and plutonium Trench T-3 (SWMU 110) contains flattened drums contaminated with uranium and plutonium Trenches T-4 to T-11 (SWMU 111) contain plutonium and uranium contaminated asphalt planking from the solar evaporation ponds Maximum radionuclide concentrations detected in groundwater during 1986 occurred in wells 22-74 and 42-86 adjacent to the east trenches These values were 0.5 pCi/l, 0.07 pCi/l, 9.8 pCi/l, 11 pCi/l and 0.21 pCi/ml for plutonium, americium, uranium-233+234, uranium-238 and tritium, respectively (DOE 1986f)

4.1.5. Present Landfill Site

Chemical hazards of concern at the present landfill may include methane and chlorinated hydrocarbons, as indicated by elevated photoionization detector readings noted while drilling wells 7-86, 8-86 and 9-86 in 1986.

4.1.6. Solar Evaporation Ponds Site

No volatile organics were detected with a photoionization detector during drilling of new wells around the solar evaporation ponds, however, chlorinated hydrocarbons may be a potential chemical hazard

Radiation is considered a potential hazard at the Solar Evaporation Ponds Site These ponds were used to contain radioactively contaminated liquid wastes (DOE 1986f)

identifying anticipated levels of potential hazards, and assigning a level of protection based on the guidance outlined above. These levels of protection may be modified by the Subcontractor Site Health and Safety Coordinator according to specific field conditions, and documented according to procedures given in Section 3.5

4.2.2.1. Activity 1 - Geophysical Surveys

For all non-intrusive geophysical surveys Level D protective gear will be used

4.2.2.2. Activity 2 - Drilling and Well Installation

Groundwater monitoring wells will be installed near the high-priority sites. Data from groundwater samples indicate that low levels of alpha radioactivity and volatile organics may be encountered when installing wells. Therefore, Level C protective gear will be initially used for all drilling and well installation activities.

4.2.2.3. Activity 3 - Development, Sampling, and Testing of Monitor Wells

Monitor wells will be developed, sampled, and tested near the high-priority sites. For reasons stated in Activity 2, Level C protective gear will initially be used for all well development, sampling, and testing activities. A photoionization detector will be used to monitor the head space of the well for organic compounds.

4.2.2.4. Activity 4 - Surface Water

Surface water will be collected from Walnut and Woman Creeks. Level D protective gear will be used for this activity.

4.2.2.5. Activity 5 - Surface Soil and Sediment

Sediment samples from Walnut and Woman Creeks will be sampled. Level D protection will be used for this activity. Surficial soil samples will be taken at the high-priority sites. Level C protection will be required at the 903 Pad Area Site and the Mound Area Site. Level D protection will be used at the other locations.

safe operation of equipment, topography of the site, extent of contamination, and potential for airborne transport.

4.3.2. Decontamination

Decontamination is required for personnel, equipment, and vehicles to prevent the spread of contamination to adjacent areas, reduce the possibility of cross-contamination of wells and samples, and protect employees. The decontamination of equipment and personnel will be conducted in steps from the exclusion zone through one or more contamination reduction zones to a final clean zone. The following decontamination procedures will be initiated after each sample or prior to leaving the contamination reduction zone. Decontamination procedures are listed by personnel protection levels.

Level D

Minimum personnel decontamination - Dispose of Level D protective clothing

Minimum equipment decontamination -

Step 1 - Wash equipment with an alkaline detergent.

Step 2 - Rinse with tap or distilled water

Level C and B

Minimum personnel decontamination - Level C and B decontamination will follow procedures as outlined by the Environmental Protection Agency (EPA 1985c)

Minimum equipment decontamination

Step 1 - Brush excess soil and wash with an alkaline detergent.

Step 2 - Rinse with tap water (from a steam cleaner).

Step 3 - Survey with both the photoionization detector probe to determine if any residual contamination exists. If so, repeat steps 1, 2, and 3 until no contamination is detected. Proceed to the next sampling location.

activities (including possible respirator use) will be evaluated and documented by a physician. Medical programs must comply with requirements of DOE Order 5480 1A Chapter VIII.

4.6. RECORDS AND REPORTING REQUIREMENTS

As stated in the CGMP and IGMP/CSPCP Health and Safety Plans, subcontractors will maintain health and safety records and submit reports, as required by DOE Orders. These reports will be distributed as defined in the IGMP/CSPCP Health and Safety Plan.

4.6.1. Exposure and Medical Records

As stated in the CGMP and IGMP/CSPCP Health and Safety Plans, subcontractors will maintain confidential medical records for each field team member. These records will identify individuals by name, date of birth, social security number, and additional identifiers as desired by the subcontractor. The employee's accident record, history of exposures, and/or possible exposures to hazardous physical, chemical, or biological agents will be included with the medical records.

4.6.2. Accident/Incident Report

As stated in the CGMP and IGMP/CSPCP Health and Safety Plans, the Subcontractor Site Health and Safety Coordinator will notify the Subcontractor Project Manager of any accidents or incidents that occur during site characterizations (remedial investigations). The Subcontractor Site Health and Safety Coordinator will also submit a completed DOE Form F 5484 X, as appropriate.

4.7. EMPLOYEE INFORMATION

As stated in the CGMP and IGMP/CSPCP Health and Safety Plans, the Subcontractor Site Health and Safety Coordinator shall ensure that the following DOE forms are posted where field team members can easily read them:

5. EMERGENCY RESPONSE AND NOTIFICATION

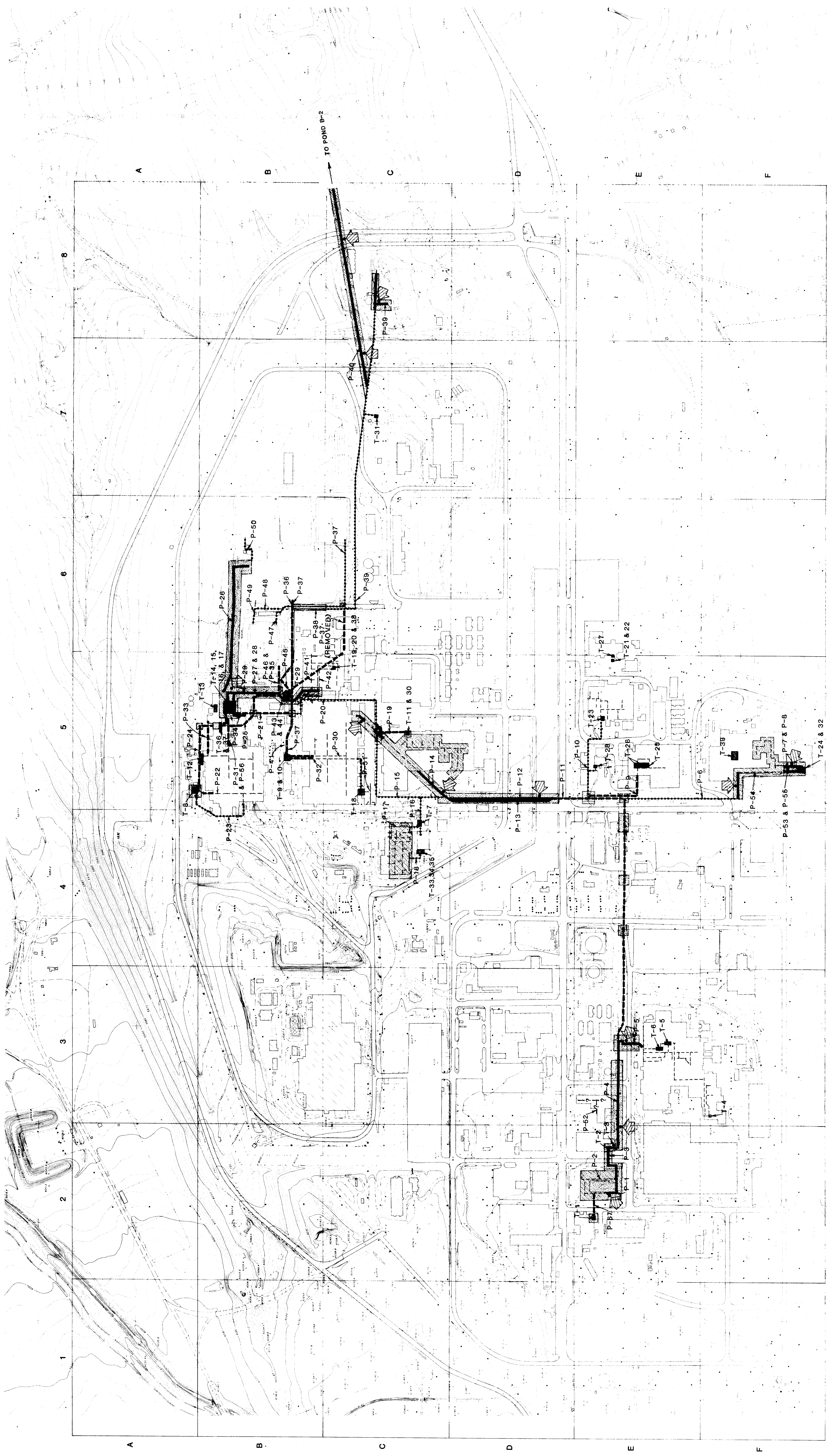
Emergency response and notification for the site characterizations (remedial investigations) will be accomplished following the guidance provided in the IGMP/CSPCP Health and Safety Plan. The emergency contacts form will be filled out and available at each work site prior to entry

6. ENVIRONMENTAL MONITORING

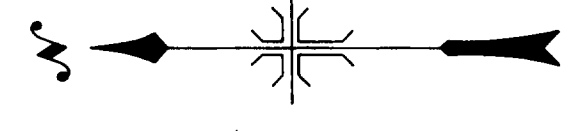
As stated in the IGMP/CSPCP Health and Safety Plan, environmental impacts from CEARP Phase 2b site characterizations (remedial investigations) are expected to be negligible. Additional sampling to supplement Rocky Flats Plant routine monitoring activities is not considered necessary. Monitoring of air quality for personnel protection will provide data to re-evaluate the need for environmental monitoring.

7. REFERENCES

- DOE 1986f "Resource Conservation and Recovery Act Part B - Operating Permit Application for USDOE Rocky Flats Plant, Hazardous and Radioactive Mixed Wastes," US Department of Energy unnumbered report, November 1986
- EPA 1984 "Standard Operation Safety Guides," US Environmental Protection Agency, Office of Emergency and Remedial Response unnumbered report, 1984
- EPA 1985c "Personnel Protection and Safety," US Environmental Protection Agency unnumbered report, Office of Emergency and Remedial Response, Washington, D C., November 1985
- NRC 1979 "Health Physics Surveys for By-product Material at NRC Licensed Processing and Manufacturing Plants," Nuclear Regulatory Guide 8 21, Nuclear Regulatory Commission report, 1979



APPROXIMATE SCALE 1"=200'



KEY TO ORIGINAL PROCESS WASTE LINES
SITE UTILITY LOCATION MAPS (APPENDIX 1)

- Key Location (row-column)
- Rockwell International Site Utility Plan drawing number
- Appendix 1 plate number
- Shaded "KEYS" indicate drawings that cover the original process waste lines and are included in Appendix 1.

	A-3	A-4	A-5	A-6	A-7
B-2	15501-3	15501-4	15501-5	15501-6	15501-7
B-3	15501-8	15501-9	15501-10	15501-11	15501-12
B-4	15501-13	15501-14	15501-15	15501-16	15501-17
B-5	15501-18	15501-19	15501-20	15501-21	15501-22
B-6	15501-23	15501-24	15501-25	15501-26	15501-27
B-7	15501-28	15501-29	15501-30	15501-31	15501-32
B-8	15501-33	15501-34	15501-35	15501-36	15501-37
B-9	15501-38	15501-39	15501-40	15501-41	15501-42
B-10	15501-43	15501-44	15501-45	15501-46	15501-47
B-11	15501-48	15501-49	15501-50	15501-51	15501-52
B-12	15501-53	15501-54	15501-55	15501-56	15501-57
B-13	15501-58	15501-59	15501-60	15501-61	15501-62
B-14	15501-63	15501-64	15501-65	15501-66	15501-67
B-15	15501-68	15501-69	15501-70	15501-71	15501-72
B-16	15501-73	15501-74	15501-75	15501-76	15501-77
B-17	15501-78	15501-79	15501-80	15501-81	15501-82
B-18	15501-83	15501-84	15501-85	15501-86	15501-87
B-19	15501-88	15501-89	15501-90	15501-91	15501-92
B-20	15501-93	15501-94	15501-95	15501-96	15501-97
B-21	15501-98	15501-99	15501-100	15501-101	15501-102
B-22	15501-103	15501-104	15501-105	15501-106	15501-107
B-23	15501-108	15501-109	15501-110	15501-111	15501-112
B-24	15501-113	15501-114	15501-115	15501-116	15501-117
B-25	15501-118	15501-119	15501-120	15501-121	15501-122
B-26	15501-123	15501-124	15501-125	15501-126	15501-127
B-27	15501-128	15501-129	15501-130	15501-131	15501-132
B-28	15501-133	15501-134	15501-135	15501-136	15501-137
B-29	15501-138	15501-139	15501-140	15501-141	15501-142
B-30	15501-143	15501-144	15501-145	15501-146	15501-147
B-31	15501-148	15501-149	15501-150	15501-151	15501-152
B-32	15501-153	15501-154	15501-155	15501-156	15501-157
B-33	15501-158	15501-159	15501-160	15501-161	15501-162
B-34	15501-163	15501-164	15501-165	15501-166	15501-167
B-35	15501-168	15501-169	15501-170	15501-171	15501-172
B-36	15501-173	15501-174	15501-175	15501-176	15501-177
B-37	15501-178	15501-179	15501-180	15501-181	15501-182
B-38	15501-183	15501-184	15501-185	15501-186	15501-187
B-39	15501-188	15501-189	15501-190	15501-191	15501-192
B-40	15501-193	15501-194	15501-195	15501-196	15501-197
B-41	15501-198	15501-199	15501-200	15501-201	15501-202
B-42	15501-203	15501-204	15501-205	15501-206	15501-207
B-43	15501-208	15501-209	15501-210	15501-211	15501-212
B-44	15501-213	15501-214	15501-215	15501-216	15501-217
B-45	15501-218	15501-219	15501-220	15501-221	15501-222
B-46	15501-223	15501-224	15501-225	15501-226	15501-227
B-47	15501-228	15501-229	15501-230	15501-231	15501-232
B-48	15501-233	15501-234	15501-235	15501-236	15501-237
B-49	15501-238	15501-239	15501-240	15501-241	15501-242
B-50	15501-243	15501-244	15501-245	15501-246	15501-247
B-51	15501-248	15501-249	15501-250	15501-251	15501-252
B-52	15501-253	15501-254	15501-255	15501-256	15501-257
B-53	15501-258	15501-259	15501-260	15501-261	15501-262
B-54	15501-263	15501-264	15501-265	15501-266	15501-267
B-55	15501-268	15501-269	15501-270	15501-271	15501-272
B-56	15501-273	15501-274	15501-275	15501-276	15501-277
B-57	15501-278	15501-279	15501-280	15501-281	15501-282
B-58	15501-283	15501-284	15501-285	15501-286	15501-287
B-59	15501-288	15501-289	15501-290	15501-291	15501-292
B-60	15501-293	15501-294	15501-295	15501-296	15501-297
B-61	15501-298	15501-299	15501-300	15501-301	15501-302
B-62	15501-303	15501-304	15501-305	15501-306	15501-307
B-63	15501-308	15501-309	15501-310	15501-311	15501-312
B-64	15501-313	15501-314	15501-315	15501-316	15501-317
B-65	15501-318	15501-319	15501-320	15501-321	15501-322
B-66	15501-323	15501-324	15501-325	15501-326	15501-327
B-67	15501-328	15501-329	15501-330	15501-331	15501-332
B-68	15501-333	15501-334	15501-335	15501-336	15501-337
B-69	15501-338	15501-339	15501-340	15501-341	15501-342
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B-71	15501-348	15501-349	15501-350	15501-351	15501-352
B-72	15501-353	15501-354	15501-355	15501-356	15501-357
B-73	15501-358	15501-359	15501-360	15501-361	15501-362
B-74	15501-363	15501-364	15501-365	15501-366	15501-367
B-75	15501-368	15501-369	15501-370	15501-371	15501-372
B-76	15501-373	15501-374	15501-375	15501-376	15501-377
B-77	15501-378	15501-379	15501-380	15501-381	15501-382
B-78	15501-383	15501-384	15501-385	15501-386	15501-387
B-79	15501-388	15501-389	15501-390	15501-391	15501-392
B-80	15501-393	15501-394	15501-395	15501-396	15501-397
B-81	15501-398	15501-399	15501-400	15501-401	15501-402
B-82	15501-403	15501-404	15501-405	15501-406	15501-407
B-83	15501-408	15501-409	15501-410	15501-411	15501-412
B-84	15501-413	15501-414	15501-415	15501-416	15501-417
B-85	15501-418	15501-419	15501-420	15501-421	15501-422
B-86	15501-423	15501-424	15501-425	15501-426	15501-427
B-87	15501-428	15501-429	15501-430	15501-431	15501-432
B-88	15501-433	15501-434	15501-435	15501-436	15501-437
B-89	15501-438	15501-439	15501-440	15501-441	15501-442
B-90	15501-443	15501-444	15501-445	15501-446	15501-447
B-91	15501-448	15501-449	15501-450	15501-451	15501-452
B-92	15501-453	15501-454	15501-455	15501-456	15501-457
B-93	15501-458	15501-459	15501-460	15501-461	15501-462
B-94	15501-463	15501-464	15501-465	15501-466	15501-467
B-95	15501-468	15501-469	15501-470	15501-471	15501-472
B-96	15501-473	15501-474	15501-475	15501-476	15501-477
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B-98	15501-483	15501-484	15501-485	15501-486	15501-487
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B-100	15501-493	15501-494	15501-495	15501-496	15501-497
B-101	15501-498	15501-499	15501-500	15501-501	15501-502
B-102	15501-503	15501-504	15501-505	15501-506	15501-507
B-103	15501-508	15501-509	15501-510	15501-511	15501-512
B-104	15501-513	15501-514	15501-515	15501-516	15501-517
B-105	15501-518	15501-519	15501-520	15501-521	15501-522
B-106	15501-523	15501-524	15501-525	15501-526	15501-527
B-107	15501-528	15501-529	15501-530	15501-531	15501-532
B-108	15501-533	15501-534	15501-535	15501-536	15501-537
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B-110	15501-543	15501-544	15501-545	15501-546	15501-547
B-111	15501-548	15501-549	15501-550	15501-551	15501-552
B-112	15501-553	15501-554	15501-555	15501-556	15501-557
B-113	15501-558	15501-559	15501-560	15501-561	15501-562
B-114	15501-563	15501-564	15501-565	15501-566	15501-567
B-115	15501-568	15501-569	15501-570	15501-571	15501-572
B-116	15501-573	15501-574	15501-575	15501-576	15501-577
B-117	15501-578	15501-579	15501-580	15501-581	15501-582
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B-119	15501-588	15501-589	15501-590	15501-591	15501-592
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B-123	15501-608	15501-609	15501-610	15501-611	15501-612
B-124	15501-613	15501-614	15501-615	15501-616	15501-617
B-125	15501-618	15501-619	15501-620	15501-621	15501-622
B-126	15501-623	15501-624	15501-625	15501-626	15501-627
B-127	15501-628	15501-629	15501-630	15501-631	15501-632
B-128	15501-633	15501-634	15501-635	15501-636	15501-637
B-129	15501-638	15501-639	15501-640	15501-641	15501-642
B-130	15501-643	15501-644	15501-645	15501-646	15501-647
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B-132	15501-653	15501-654	15501-655	15501-656	15501-657
B-133	15501-658	15501-659	15501-660	15501-661	15501-662
B-134	15501-663	15501-664	15501-665	15501-666	15501-667
B-135	15501-668	15501-669	15501-670	15501-671	15501-672
B-136	15501-673	15501-674	15501-675	15501-676	15501-677
B-137	15501-678	15501-679	15501-680	15501-681	15501-682
B-138	15501-683	15501-684	15501-685	15501-686	15501-687
B-139	15501-688	15501-689	15501-690	15501-691	15501-692
B-140	15501-693	15501-694	15501-695	15501-696	15501-697
B-141	15501-698	15501-699	15501-700	15501-701	15501-702
B-142	15501-703	15501-704	15501-705	15501-706	15501-707
B-143	15501-708	15501-709	15501-710	15501-711	15501-712
B-144	15501-713	15501-714	15501-715	15501-716	15501-717
B-145	15501-718	15501-719	15501-720	15501-721	15501-722
B-146	15501-723	15501-724	15501-725	15501-726	15501-727
B-147	15501-728	15501-729	15501-730	15501-731	15501-732
B-148	15501-733	15501-734	1		